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THE JAPANESE SKIPJACK FISHERY

SPECIAL SCIENTIFIC REPORT: FISHERIES No. 49

UNITED STATES DEPARTMENT OF THE INTERIOR
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Explanatory Note

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THE JAPANESE SKIPJACK FISHERY

Translated from the Japanese language by

W. G. Van Campen
Pacific Oceanic Fishery Investigations

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The Skipjack Fishery

Chapter I

Development of the Skipjack Fishery

The skipjack fishery originated in ancient times and there are various theories about its origin but no details are known. The skipjack is not to be found among the names of fishes in Dr. Kishinouye's report of studies based on findings in shell heaps. The fishes eaten by the people of that period were probably limited to those which were easy to catch and did not in all likelihood include many of the more active species. Swift-moving fishes like the skipjack were probably not made the object of a fishery by the people of that time because it would be impossible for them to catch such fish.

With the later intellectual improvement of the human race methods were devised for taking the skipjack, and probably the first to be discovered was the use of hook and line. This development can be pictured from the legend of Umi-no-sachi and Yamano-sachi. The skipjack fishery probably originated as the race progressed from the prehistoric period when fish and shellfish were taken with the bare hands to the period in which they were attracted and taken with fishing gear. Conditions in this period can be imagined on the basis of the mention made of skipjack in the Kojiki and the Nihon Shoki [ancient annals of Japan]. The skipjack fishing poem of Urashima of Mizunoe appears in the Manyoshu, the most ancient anthology of Japanese poetry, and it is recorded in the Yamatohime Seiki that when the enshrinement of the imperial ancestors was celebrated at Ise, the chief celebrant, Yamatohime, offered a large quantity of skipjack at the main shrine. This seems to show at any rate that the Japanese skipjack fishery has been carried on since rather ancient times, and that at that time it was prized as a valuable fish.

The region in which skipjack were caught extended all along the Pacific coast, and fairly large numbers seem to have been taken. About twelve hundred years ago in June of the ninth year of the Tempyo Era in the reign of Emperor Shomu, because evil practices were rife, the Prime Minister gave orders to the governors in the regions of Tokai, Tozan, Sanin, and Sanyo to take heed of the regulations on foodstuffs. The eating of raw mackerel and scads was prohibited, but an exception was made in the case of skipjack and it was permissible to eat them raw. From this it is deduced that at that time the fish was widely used for food and that it was produced in rather large quantities. Judging from the fact that skipjack were eaten raw in the localities mentioned above, we can infer the following general state of affairs. In view of the transportation situation of the time and the level of development of techniques for preserving the freshness of the fish, it appears that skipjack were taken on the coasts of the Tokai, Tozan, Sanin and Sanyo regions and that the fish were used to supply the demand within those regions. The provinces mentioned in this connection in the Engishiki are Shima, Suruga, Izu, Sagami,

Awa, Awa [nami], Hyūga, and Kii. This was the beginning of the period of the coastal fishery for skipjack.

Section 1 The Period of the Coastal Fishery

This period extends to end of the Edo Period, when the people were so charmed by the flavor of the first skipjacks of spring that they composed such poems as

Kamakura no
Umi yori ideshi
Hatsugatsuo
Mina Musashino no
Hara ni koso ire

The first skipjack which come
From the seas of Kamakura
All disappear into
The bellies of Musashino.

The first market of the year for skipjack was held on the Buddha's birthday, which according to the old calendar was April 8th. That is to say that in the period of the coastal fishery the fishing season in the Kantō region began around April 8th of the old calendar, which means that the fishermen waited until the skipjack migrated into the waters close to Kamakura. The demand for the fish was great since at that time of the year the flavor of the skipjack was excellent and since it accorded with the spirit of the people of Edo to treat the fish as a harbinger of spring. These facts, together with the fact that as the manufacture of dried skipjack sticks became general the populace acquired a taste for the fish, and its being prized by the warrior class also were all factors in the promotion of the skipjack fishery. The coastal fishery became a profitable enterprise and this led to its further development as a peculiarly Japanese fishery. The fulness of the development of the coastal fishery and the wealth of experience gained in it became the central factors in the opening of the next period of the fishery's progress and as the fishery spread in its own peculiar form all over the world these factors have formed the foundations of its present state.

From the point of view of the boats used this was the era of Japanese-style vessels, moved for the most part by man power with oars and sculls. The progress of the skipjack fishery has been parallelled by progress in fishing boat construction.

Let us examine the history of the development of the skipjack fishery and of fishing vessels in the provinces. This was a period in which when the warm waters of the Kuroshio moved north along the coast of Japan large schools of skipjack would follow the current and migrate in close to shore. Neither the land nor the sea had as yet been sullied by machine civilization, the water was clear and clean, there were no man-made obstructions, and the great schools of skipjack could swim about at their leisure in search of food freely and safely. They could be taken freely in waters

2 to 6 miles off the coast, and the fishing grounds for skipjack were all within 10 miles of the coast.

As a result of the fishing grounds' lying so near the coast the season necessarily began when the fish appeared within the operating range of the fishing boats and ended when they departed. Positive measures such as following the schools were unknown and the fishery was operated entirely on a passive basis.

The following is a sketch of developments at various places during the period of the coastal fishery.

(1) The Makurazaki area of Kagoshima Prefecture.

A regular skipjack fishery has been carried on in this area for about 350 years. Technical instruction was received from the Kii and Tosa areas and the boats used were chiefly powered by sails and oars. The fishing grounds were within several miles of the coast, and the boats, which were made of wood, were of the box-type construction peculiar to this area. The fishing season was the earliest of any place in Japan, the catch was stable, and a great many people depended for their living on skipjack fishing.

(2) Kōchi Prefecture area

About 450 years ago fishermen of Kumanoura in Kishū, who had taken skipjack off Ashizuri Misaki, drifted in to Tosa and taught skipjack fishing to the people of this area.

(3) Katsuura area of Wakayama Prefecture

Skipjack fishing in Japan really started in this region and the techniques used here have spread throughout the country. The year in which the fishery began here is unknown, but it is prior to those cited above. The most flourishing period in this region was from the first years of the Meiji Era [about 1868] to around 1888, the fishing being done at this time from seven-oared Japanese-style boats. The boats were about 8 feet wide by 40 feet long, manned by a crew of 15, and propelled by seven oars. The fishing grounds were generally 5 to 6 miles off the coast, 12 miles at the farthest. It was day fishing, the fishermen assembling at the boat-owner's place about 1:00 a.m. to go out fishing and returning at any time from noon to 6:00 p.m. In other words they fished mainly in the morning and one boat took from 500 to 2,000 fish per day. The season was from the 4th to the 7th month of the old calendar and, as the local saying "When the grain is the color of loquats, we must go and fish for skipjack off Ida." shows, the fishing usually began in the Shingū and Ida areas between April and June.

(4) Shizuoka Prefecture area

The origin of the skipjack fishery in this area is unknown, but it probably began before the Tempo Era [1830]. At that time Japanese-style

boats of about 6-foot beam were employed with crews of 15 men, and the fishing grounds were limited to Suruga Bay.

(5) Katsuura in Chiba Prefecture

Until the end of the Meiji Era [1911] Japanese-style sailing vessels of about 8½-foot beam and about 40 feet in length were used with crews of 16 men. The fishing season began in the 4th month of the old calendar, and the grounds were 5 to 6 miles off shore with Katsuura as the center of the fishery.

(6) Hiraiso area in Ibaragi Prefecture

The fishery was started in this region about 100 years ago. Small Japanese-style boats were used and they operated only very close to the coast. At that time many skipjack came in to the coast and the boats used to go out twice a day with very good success.

(7) Kesennuma area of Miyagi Prefecture

The fishery in this area got started about the first years of the Meiji Era [around 1868]. At first the fishing grounds were 3 to 6 miles off the coast and Japanese-style hand-propelled boats were used, sailing vessels gradually coming into use later. The fishing season was the 6th month of the old calendar.

Section 2 Period of the Fishery in Adjacent Waters

After the period of coastal fishing the skipjack fishery entered upon the period of fishing in adjacent waters. This development was chiefly due to changes in the fishing vessels. With the advance from the era of hand or sail-powered Japanese-style boats to the era of engine-powered vessels, the area of operation surpassed its former limits of 5 to 10 miles off shore and was enlarged to an average distance of about 40 miles, taking on quite a deepsea character considering the navigational techniques of the time. Piloting was in its infancy and the boats operated within the limits of the so-called yamadake method, that is, using the tops of the mountains for landmarks. This era of piloting by eye was the era of the fishery in adjacent waters.

During the period of the coastal fishery the fishermen occupied a passive position with regard to fishing grounds and fishing seasons, but the advent of the period of fishing in adjacent waters gave them a certain degree of aggressiveness and the ability to select their own fishing ground and season. Consequently the catch per boat far exceeded that of the preceding period.

(1) Kagoshima area

The fishery here changed from a coastal to an offshore fishery about 50 years ago. At this time powered vessels made their appearance and boats of from 20 to 30 tons were built, but these motor-sailers continued

to be the box-type or Kagoshima-type boats peculiar to this region. The fishing grounds were extended to the coasts of the seven islands south of Kagoshima [Satsunan Shichitō], and as the fishery was directed at both migratory fish and shoal-dwelling fish the fishing season was necessarily lengthened, the catch was doubled, impetus was given to the production of Satsuma dried skipjack stick, the industry was greatly developed, and the Kagoshima skipjack fishery attained wide fame.

(2) Kōchi area

The beginnings of the skipjack fishery in this region were in 1906 when an engine was installed in the Kōchi Prefectural Fisheries Experiment Station's Himejima Maru. Stimulated by the good results of this experiment, the fishery flourished from 1907 to 1920. The fishing grounds were gradually extended farther out to sea, and the season was also extended until it began around March or April, hit its peak from April to May, and ended in June or July.

(3) Kishū area

In 1909 the skipjack boat Sakigake Maru (10 tons) was equipped with an engine, and its success stimulated the construction of boats averaging 15 tons with engines of about 28 horsepower, and capable of 2 or 3 day voyages. The season was extended, with the peak in April, May, and June, and the catch greatly increased.

(4) Shizuoka area

In 1903 Mr. Bunshichi Maruo put an engine in the Chidori Maru operating out of Shimizu Harbor. This experiment was a failure, but it resulted in the installation of an engine in the Fuji Maru of the Prefectural Fisheries Experiment Station. In 1908 an engine was installed in the first newly-constructed Western-style fishing vessel, and about this time engines of 10 to 15 horsepower were installed in the old Japanese-style boats. As a result the fishing grounds were extended from the Izu Shichitō to the Hachijōjima area, the fishing season was prolonged, the catch was increased, and the Yakizu dried skipjack stick was produced in greater quantity and acquired a high reputation.

(5) Chiba area

At the beginning of the Taishō Era [1912] a 20 horsepower engine was installed in a sailing vessel with good results. By about 1916 many powered vessels were in operation and both the fishing grounds and the fishing season had been greatly extended.

(6) Northeastern region

Around 1912 the fishing grounds were gradually being extended to seaward, powered vessels were putting in their appearance, and the fishery was developing more and more. In the beginning engines of 8 to 10

horsepower were used with good results, and the summer skipjack fishing season came to occupy a position of importance.

Thus in the period of the fishery in adjacent waters mobility was added to the elements which had developed during the period of the coastal fishery. This was a time of preparation for the gradual shift to the era of the fishery in distant waters, and great forward strides were made within a few years' time. This period has a very important significance because of the advancement of the techniques which have led to the present state of development of the skipjack fishery.

Section 3 The Period of the Fishery in Distant Waters

When the engines which had been installed during the period of fishing in adjacent waters had passed through their experimental phase, they entered upon the period of their active employment, and during the Shōwa Era [1926 to present] the fishery in distant waters developed. Now the skipjack fishery took on an aggressive character, and instead of waiting for the migrations of the fish as they had before the fishermen began actively to seek the schools in distant seas. Fortunately, because of Japan's freedom from foreign entanglements, the fishing fleets were able to find bases of operations in distant waters anywhere they pleased, and there were no obstacles of any sort to the establishment of the industry. The skipjack fishery thus entered upon its golden age.

At this time vessels began to operate from the coasts of Japan to distant Taiwan and the South Seas, and as a result the fishing season was freed of its natural limitations. Year-round fishing became possible, methods of handling and storing the catch were rapidly improved, the limitations on days of operation were greatly relaxed, and it became possible to make long voyages.

At the same time scientific studies of the migrations and habits of the skipjack were advanced, and the methods of fishing, which hitherto had been based on personal experience and observation, were rationalized, so that anyone, even without long experience in the fishery, could engage in it with comparative ease and a fair degree of success. In addition the wide dissemination of navigational techniques and the construction of stronger vessels contributed to the progress of the skipjack fishery.

(1) Kagoshima area

Fishing vessels are from 50 to 260 tons, with the average about 100 tons. Crews number 20 to 80 men, and the fishing grounds extend over a radius of 2,000 miles to the South Seas, Taiwan, Celebes, and Borneo. The main fishing grounds are from the Satsunan Shichitō to the vicinity of the Yaeyama Chain, and the fishing season is all the year round.

(2) Kōchi area

The fishing boats in this area are comparatively small and operate 70 to 100 miles off Muroto Saki and Ashizuri Saki. The fishing season is from

Table 1 Distribution of the Catch by Fishing Grounds During the Period of the Fishery in Distant Waters (in units of kan [1 kan = 8.27 lbs.])

Year	Japanese Coast	Japanese Offshore	Taiwan	South Seas	Total
1927	3,597,194	19,257,967	786,495	14,120	23,655,778
1928	2,971,176	17,559,195	861,120	43,658	31,435,149
1929	3,196,382	16,040,225	870,924	125,200	30,232,731
1930	2,967,021	15,377,896	550,885	356,200	19,252,002
1931	3,031,434	18,394,324	494,086	751,148	22,670,992
1932	3,655,125	14,250,971	278,001	1,296,736	19,480,833
1933	3,241,694	17,347,258	567,312	1,826,504	23,009,768
1934	4,260,064	18,384,660	517,968	2,388,406	25,551,098
1935	2,911,153	16,524,676	541,712	3,125,981	23,103,522
1936	4,062,218	22,880,510	438,448	3,804,739	31,185,915

April to August. At this time fishing boats from this area do not fish very much in other areas since schools of fish are plentiful in the nearby waters and there is no necessity of seeking distant bases elsewhere.

(3) Wakayama area

The fishing boats of this region do not fish in distant waters, operating mainly on grounds 70 to 80 miles offshore, and consequently most of the boats are small. They are comparatively speedy boats of 20 to 30 tons displacement, and the fishing methods used represent merely a rationalization of those employed during the period of the fishery in adjacent waters.

(4) Shizuoka area

The fishing boats average 25 tons, and operate actively at Torishima, in the Ogasawara area, off Kishū, and off Sanriku. The season is from April to October.

(5) Chiba area

The fishing vessels are comparatively large and fish in the Ogasawara and Zunan areas, moving into the coastal waters thereafter. The season is from April to September.

(6) Northeastern area

Larger boats have come into use as the fishing grounds have shifted out to sea, and the vessels are now of 30 to 80 tons displacement. They operate at distances of 70 to 120 miles offshore, and the season extends from May to September.

In this way the pattern of operations has changed in all areas as the potentialities of the vessels have increased, a course toward further development has been taken, and the fishery has attained its present condition.

Section 4 The Present Condition of the Skipjack Fishery

The skipjack fishery, which had advanced into the era of the fishery in distant waters since the beginning of the Shōwa Era [1926], entered with the outbreak of the war on a period of complete stagnation. At the close of the war it was hastily started up again and in spite of the ravages which war has left upon it the industry is continuing its efforts toward reconstruction.

According to the report for June, 1948, of the Fisheries Bureau, registered skipjack boats (including vessels which fish part of the time for tuna) numbered 1,420 vessels totaling 60,479 tons. Published figures on the 1947 catch were 11,5[illegible] tons in June and 13,245 tons in July.

Local peculiarities are gradually disappearing and at present all of the fishermen share common techniques, only the quality of the fishing vessels remaining as a controlling factor in the success of the fishery. However, operations are being carried on in the face of shortages of necessary materials and under all sorts of controls. The skipjack fishery furthermore has many problems inherent in it.

The skipjack suits the eating habits of the Japanese, and the fishery has continued through many vicissitudes from ancient times to the present day. When we consider the fact that the same method of fishing has been used during all this time, we are amazed that a method originating in the distant past should be so superior for taking skipjack. At the same time we are faced with the pressing and important problem of further improving the strong points of this technique and devising ways of dealing with its weaknesses.

@ Let us try to collect references to the skipjack from ancient poetry.
@ Let us try to get old stories of skipjack fishing from the old men.
@ Let us try to find out where the skipjack sold in our neighborhoods is brought from and where it is caught.
@ Let us try to go and see skipjack fishing vessels and hear accounts of the fishing.

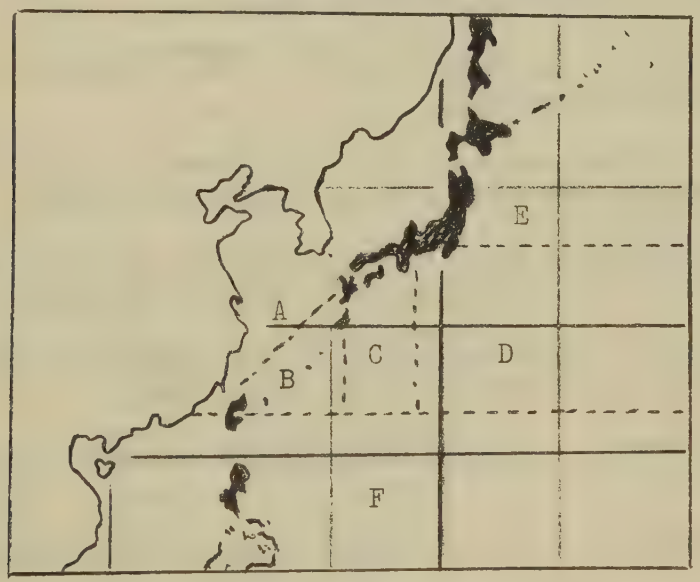

Figure 2 Sea areas

A. Northwestern Area
B. Satsunan Area
C. Kinan Area
D. Zunan Area
E. Northeastern Area
F. South Seas Area

Chapter II

Characteristics of the Skipjack

Just what kind of a fish is this skipjack, which suits so well the taste of the Japanese and is so particularly prized by them?

Taxonomically, it belongs to the mackerel family. It is rather short and stout and only slightly flattened laterally so that the outline of a cross-section is nearly oval. The snout is pointed and there are no scales except on the corselet. The first dorsal has 15 spines and the second dorsal has 2 spines and 13 rays and eight finlets. The anal fin has 2 spines and 13 rays and seven finlets. The upper part of the body is a dull blue and the lower part is silvery white. There are from four to ten longitudinal dark blue stripes along the sides of the body. As the fish increases in size, their number decreases. The fish originate mainly in the tropics, and in the summer and autumn, they migrate along the warm currents to distant Hokkaidō. The skipjack attains a length of 2 feet, 10 inches, and a weight of around 5 kan [41.35 lbs.]. This fish also occurs in the Atlantic and the Mediterranean. [Fig. 3 follows this page].

In the following discussion of the skipjack fishery, we have, for the sake of convenience, divided the ocean into areas in accordance with the divisions in use hitherto as shown in Figure 2.

(a) Northeastern Area (or Sanriku Area) -- the area north of a line drawn southeast from Nojima Saki.

(b) Zunan Area -- the area east of a line drawn due south from Omae Saki and extending to the limits of the Northeastern Area.

(c) Kinan Area (Nankaido Area) -- the area east of a line drawn due south from Hi Saki and extending to the limits of the Zunan Area.

(d) Satsunan Area -- the area east of a line drawn from Noma Saki to Fuki Kaku (Taiwan) and extending to the Kinan Area.

(e) South Seas Area -- the area south of the latitude of Anpin Anchorage in Taiwan.

(f) Northwestern Area -- the area west of the Satsunan Area. Fig. 2 - Sea Areas.

Section 1 Outline of the Distribution

1. Skipjack of Japan

The skipjack which come into Japanese waters come north from the South Seas in the warm waters of the Kuroshio or Japan Current. The northern equatorial current, striking the Philippines, turns northward and passes along the east coast of Taiwan and the islands of Okinawa into the adjacent

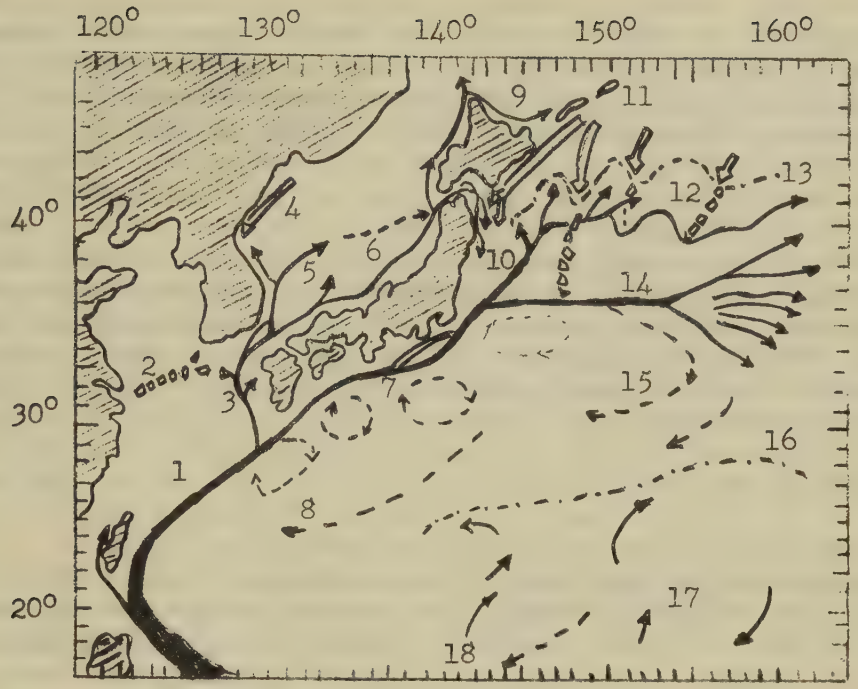

Figure 3 Warm and cold currents

warm currents

cold currents

1. warm Kuroshio current
2. water of low chlorinity from the Yellow Sea
3. Tsushima warm current
4. North Korean cold current
5. East Korean warm current
6. Tsushima warm current
7. Kuroshio warm current
8. Kuroshio counter-current
9. Sōya warm current
10. Kuroshio branch current
11. Oyashio cold current
12. Oyashio undercurrent
13. line of the front
14. main current of the Kuroshio
15. Kuroshio counter-current
16. subtropical line of convergence
17. vortex
18. Northern Equatorial Current

waters of Japan. In the spring and summer, northward-flowing branches stem off from it at various points, and the skipjack which appear in the waters off Japan are carried by these warm currents. Beginning in the Kagoshima region, they appear successively farther north and finally reach the waters off the southern Kuriles. As the cold current of the Oyashio becomes stronger in September and October, the fish move southward and return to the South Seas, but in places like the Okinawa, Kagoshima, Zunan Shotō, and Ogasawara areas, where the warmest parts of the water masses of the warm current systems flow over shoals, they divide into the shoal skipjack, which make the shoals and their vicinities such good fishing grounds, and the deepsea schools which congregate and move in accordance with the developments of the main warm current system. The shoal skipjack schools are present the year round, while the deepsea schools appear periodically.

2. Skipjack of Taiwan

The skipjack fishery of Taiwan was started by Japanese in 1909. At first, the operations were carried on between the Senkaku Is. on the north and Kashō I. and Kōtōsho on the south and as far east as the waters off Yaeyama. Since that time, the form of the fishery has gradually been improved and vessels from Kirun, Suō, Karenkō, Taitō, and Takao have been operating at great distances from shore. The schools are densely distributed, and both schools of mature fish and schools of small skipjack are seen. An indication of the density in which the fish occur is provided by the figures on the catch, which were 491,260 kan in 1934, 294,424 kan in 1935, and 404,154 kan in 1936. [1 kan = 8.27 lbs.]

There is a limit to the demand for Taiwan skipjack and this operates to control the catch naturally, however, the fish are present in dense concentrations throughout the year.

3. Philippine Islands

(1) Batan Strait to seas east of Luzon -- This area is traversed by the ascending main stream of the Kuroshio and skipjack schools occur there, but we have no detailed knowledge of them as yet.

(2) Samar vicinity -- In this area, there are bays and outlying islands where sardines, mackerel, and mackerel-scad occur, and large schools of skipjack which feed on these fishes concentrate densely between Samar and the Hiraban Is.

(3) Southern Mindanao -- Dense schools are always seen from the vicinity of Zamboanga to the eastern part of the Gulf of Davao. Skipjack are also found in the western waters between Zamboanga and Panay I.

(4) West coast of Mindoro I., Manila Bay -- In this area, dense schools are seen 2 - 3 miles off shore, and many schools of Auxis thazard and small skipjack also occur here.

The waters adjacent to the Philippine Is. are the original home of the skipjack schools which migrate to Japan. Schools of all types are universally distributed throughout the area and the fishing season is all year round, but the peak season is from October to January, when schools of "island skipjack" which migrate close in to the coast are fished.

4. South Sea Islands

The South Sea Islands area is in the deep part of the Pacific Ocean, and from the Carolines group in the low latitudes, it stretches intermittently east and west for about 2,000 miles. At the center, the Marianas chain runs northward, and the Marshalls form the eastern limit where they extend for 700 miles north and south. Among these archipelagoes, the North Pacific Equatorial Current and the Equatorial Countercurrent flow in complicated patterns, and migratory fishes of the surface waters are distributed everywhere. Accordingly, skipjack schools may be seen throughout the area at all seasons of the year. [Insert Fig. 4.]

The schools in this area are the source of the schools which migrate into Japanese waters, and it may be said that the fluctuations of the skipjack in these waters control the Japanese fishery.

5. Borneo, Celebes (English Territory)

The skipjack schools in Borneo waters come so extraordinarily close to shore that they are taken with a type of weir called a keiron. The fish are universally distributed throughout these waters. In the Celebes area, the fishery is centered around Menado, Ternate, and Sangi I., and dense schools are widely distributed.

6. Halmahera, Sangi Is. (Netherlands East Indies)

Halmahera, Talaud I., Sangi Is. The skipjack schools which occur between these islands are large, and the fish range in size from 2 kan [16.5 lbs.] to 160 momme [21.2 oz.].

7. Ambon I. (Malacca Is.) [Moluccas ?]

Skipjack schools come in close to the coasts and are widely distributed in the waters east and west of this island.

8. Australian area

The fish are distributed from southern Queensland to northeastern Tasmania and St. Helen's I., with the waters off Victoria as the center. The fish also migrate into the waters off New Zealand and Lord Howe I. They are from 1.4 to 7.3 kilograms in weight, with schools of four-year old fish weighing 2.7 to 4.5 kilograms making up 80% of the population. This is similar to the make-up of the schools on our Sanriku [Northeastern] grounds. [Fig. 5.]

9. California Coast to Mexican Coast

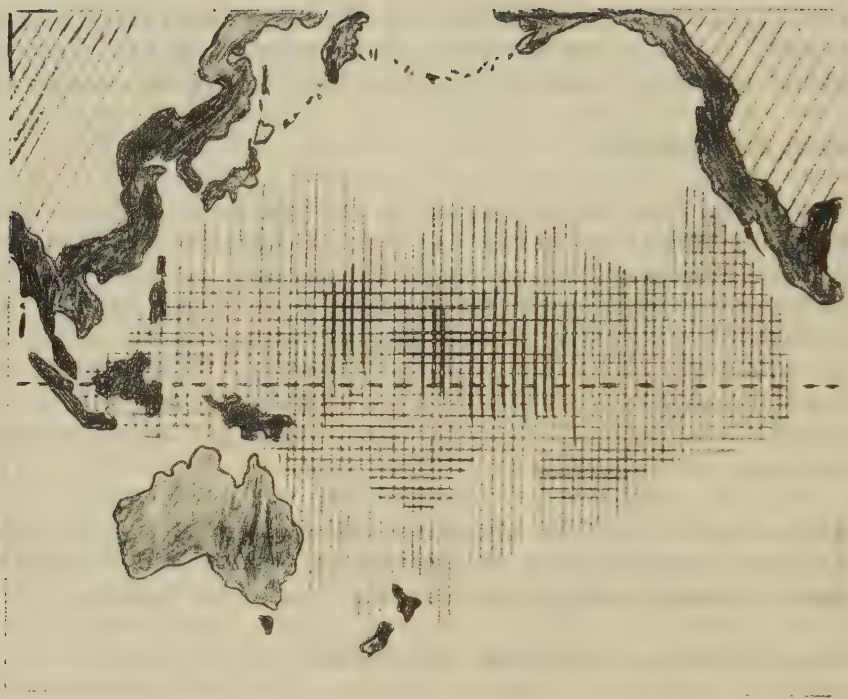

Figure 4 Outline of skipjack distribution

seasonal

year-round

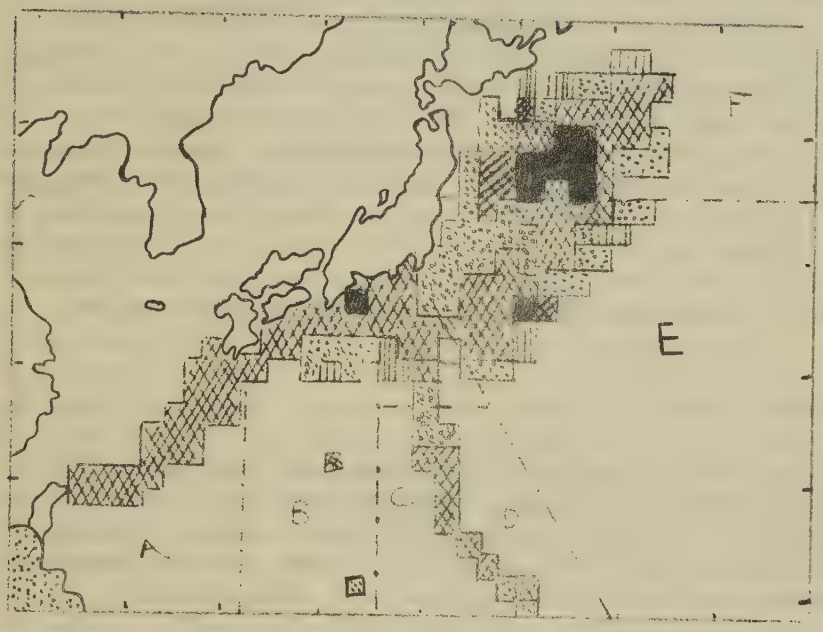

Figure 5 Chart of the distribution of skipjack fishing grounds (1937)

Legend showing the catch within each degree of latitude and longitude

1,000 - 10,000 fish

10,000 - 100,000 fish

100,000 - 1,000,000 fish

1,000,000 - 2,000,000 fish

A. Satsunan Area

B. Kinan Area

C. Izu Is. Area

D. Ogasawara Area

E. Southern part of the Northeastern Area (off Tokiwa and Nojimazaki)

F. Northern part of the Northeastern Area (off Sanriku)

Schools of fish are present in these waters, where they are known as "sukiipujyakku."

Thus the skipjack is distributed throughout a wide area of the Pacific centering on the Equator, and although there are seasonal differences in density, they occur in these waters at all times. Beginning in the latter part of February, detached schools pass the Nansei Shotō and appear in the Satsunan area, while other schools appear from the Marianas to the Ogasawara and Zunan areas. In mid-summer, they migrate into the Sanriku area, but in the autumn, they turn southward and disappear, leaving no skipjack population in those waters. The fact that the distribution of skipjack in Japanese waters is, for the most part, related to this one pattern of migration, has been the reason for the development of the peculiarly Japanese method of fishing and has set the stage for the skipjack fishery.

Section 2 Outline of Migrations

The general term "skipjack" [katsuo] includes four species, the true skipjack [magatsuo], the sumagatsuo [Euthynnus yaito], the hagatsuo [Sarda orientalis], [Auxis thazard]. These are all tropical fish which always live in sea areas which have high water temperatures. They migrate into Japanese waters with the Kuroshio in the summer.

(1) Sumagatsuo (yaito) (watanabe) [Euthynnus yaito]

This skipjack is without longitudinal black stripes on the sides and has several black spots below the pectoral fin. It characteristically likes to live in the swift currents off promontories. A coast-dwelling fish, it prefers to stay close to islets, reefs, banks, and shoals. While it does inhabit swift currents, it avoids the heart of the current and swims in the comparatively slack water. The fish characteristically chooses a place for its nest and stays there, spotting with its keen eyes the crustaceans, squid, and small fish which come drifting by and catching them for food. It will sometimes pursue its prey up toward the surface, but usually returns to its nest without going very far. In the dim light of morning and evening these fish leave their nests and forming small schools leap about on the surface. They rarely migrate out into the open sea and even when moving from island to island they usually do not rise to the surface layers. For these reasons they are unsuitable as the object of a skipjack fishery, and they seldom migrate north of Chōshi.

(2) Hagatsuo (sujigatsuo) (kitsunegatsuo) (hosan) [Sarda orientalis]

This is a fish of the offshore waters and generally swims close to land at moderate depths. They migrate into Japanese waters in small schools. On their way north they are taken in set nets at places where the current passes close to shore or at promontories, or when they chase young anchovies into the bays. They ordinarily live close to land and rarely go out into the open sea. They take dead bait as well as live bait. They also migrate north in the Japan Sea. The dorsal portion of the body has many fine longitudinal stripes, and the teeth are long and sharp.

(3) Sōdakatsuo (mandara) (subota) (rōsoku) /Auxis sp./

There are two species of sōdakatsuo, the marusōdakatsuo /Auxis maru/ and the hirasōdakatsuo /Auxis hira/. Both like high temperatures and live in the Kuroshio. The marusōdakatsuo is a coastal fish, prefers the swift currents around promontories, and comes into the bays in schools. They come north on the Pacific coast as far as Shiriya Misaki in Aomori Prefecture and also enter the Japan Sea. They use their caudal fins to maintain their position in swift currents and cleverly capture food which comes drifting down to them. At morning and evening and in cloudy weather they sometimes leave the swift currents in search of food and school at the surface.

The hirasōdakatsuo has the body more flattened laterally than the preceding species, and is more of a pelagic fish. It lives around islands and promontories, and its nature is much like that of the sumagatsuo. They do not form large schools, but sometimes mingle with the true skipjack, and in the summer they swim into the waters of the Sanriku area /Northeastern area/. Both species are warm water fish and from their migrations it is possible to judge the fluctuations in the Kuroshio. Around the autumn equinox the schools which have been migrating north turn southward again. Because of their structure these fish swim in a straight line; their bodies are torpedo-shaped. They cannot make short turns and they are lacking in buoyancy. They swim strongly and continuously and have finally become adapted to living in currents so that their resting places are limited to places which have swift currents. They always live in clear water and are very sensitive to any intrusion of freshwater running off from the land. This species has wavy markings on the back, the snout is short, and the eye is located far forward.

Paragraph 1 Ecology of the True Skipjack

The true skipjack /Katsuwonus pelamis/ is the most pelagic of the skipjacks. It swims continually in schools out at sea and performs great periodic migrations north to the limits of the Oyashio. The skipjack fishery in Japanese waters has grown up in dependence upon this species.

1. Spawning areas of the true skipjack

The skipjack's spawning grounds are in areas of suitable warm water where there is plenty of food for the development of the young fish. They spawn and develop in the southern waters, and when they reach their prime, they become aware of the instincts proper to the skipjack and start on their long migration north. In the spring and summer they pass through Japanese waters and about the time of the autumn equinox they return to the southern seas. In this fashion they continue for many years to migrate north and south. When they reach old age and no longer have the strength and spirit to go north, some of them find a suitable place along the path of migration and take up their residence on a reef or shoal, becoming the so-called "shoal skipjack", while others leave the migratory schools before the migration begins and live out their lives quietly in the South Seas.

In this fashion the skipjack spawn and grow up near the islands and reefs in tropical waters. These waters are south of 24° North Latitude, and their surface temperatures are above 20°. It appears that the skipjack schools make their permanent homes there and pass the winter there. Within this area they spawn principally at places close to islands and reefs. Besides those which spawn in the South Seas, skipjack with ripe eggs are also taken in the Okinawa and Ogasawara areas. It appears that some skipjack also spawn in those waters. In short, the spawning grounds of the skipjack extend over a rather wide area with the center of spawning activity in the South Seas.

2, Development of the Skipjack

(1) The small skipjack stage (weight 300-400 momme [39.7-53 oz.], 1-2 years old)

The juvenile fish are slender and thin. They like to leap about on the surface of the water. They eat mainly schizopods, amphipods, larval decapods, and small anchovies. The island-dwelling schools will not come to chum-bait and they are still very timid so that when a vessel approaches them they tend to submerge suddenly. Once they get out into the open sea and enter upon the pattern of migration, however, they gradually come to take the bait better and better. The schools of descending skipjack returning south after the equinox are not skillful in the competition for food and they are liable to have empty bellies, which makes them take the bait very well.
Note: "Descending skipjack" are those which are returning south in the fall after their northward migration. "Water pushing [mizuoshi]" is a term used to describe the turbulence of the surface where a school is feeding. When they sight the prey, the whole school deploys in a line of foragers and advances through the school of bait with the fish showing their dorsal fins above the surface. The turbulence caused by their tails gives rise to long continuous ripples on the surface which make the area readily distinguishable from the surrounding waters.

(2) The medium skipjack stage (weight 600-800 momme [4.96-6.62 lbs.], age 3 to 4 years)

These fish are the main element in the skipjack schools which migrate into Japanese waters. Their bodies are perfectly fusiform. They are strongly migratory and rather than take up residence on a shoal or around an island and eat crustaceans, they prefer to swim swiftly in the open sea hunting schizopods, small fishes, and squid. If they do become attached to a shoal, they do not remain there long. They form large groups of schools and swim through the surface waters in orderly and disciplined fashion searching for food. They generally take the bait well. They have already become adept at mizuoshi, and have learned to herd bait and to accompany sharks and whales. At times they also follow floating logs for thousands of miles of leisurely migration.
Note: The term "[illegible] [tadachiawakuri]" is used to describe the action of the skipjack school in surrounding a school of small sardines

and driving them into a tight mass while greedily feeding around the edges. Skipjack schools sometimes accompany kambeizame [a species of shark] and sardine whales.

(3) The large skipjack stage (over 1,000 momme [8.28 lbs.] weight, 6 to 8 years old)

In this stage of development the body depth increases greatly in relation to the length, the fish becomes stouter, and its movements become slower. Its food consists of squid, crustaceans, and miscellaneous fish. The fish generally move to the reefs of outlying islands and become deficient in schooling instinct with a tendency to remain in small groups at "fish nests". Until they attain a weight of about 2,000 momme [16.56 lbs.] they retain some of their migratory tendencies, but old fish over that weight do not migrate and remain all the year round permanently resident at the fish reefs of the low latitudes. Or they may wander around the open sea together with the albacore and come to live in waters as cold as 18°C. They have a strong tendency to become what is commonly called dekiuwo ["adventitious fish"] and generally keep to the lower depths, rising to hunt food only at certain tides or in the dim light of morning and evening.
Note: Dekiuwo are fish which are attracted to the surface by chum-bait or trolling lures.

Paragraph 2 Migrations

It is instinctive with the skipjack schools of the southern seas to migrate regularly into Japanese waters in the spring and summer of each year. That is, while instinctively migrating in search of food they enter the waters adjacent to Japan, but viewed objectively the migration is controlled by the currents in the waters which the fish inhabit. As shown in Fig. 3, the Northern Equatorial Current runs from east to west the year round in the vicinity of 5 - 10° north latitude. In the waters adjacent to the Philippines it changes from a westerly to a northerly current, flows along the east coast of Taiwan, continues north along the Okinawa chain, and impinges upon the coasts of Japan beginning with southern Kyūshū. From the middle of March, when the Kuroshio is at its height, a part of the fish which live within the Equatorial Current follow it and are naturally brought into the adjacent waters of Japan.

If we were to classify skipjack schools from the point of view of their migrations, it is assumed that the classification would be as follows:

(a) Schools which spend their whole lives in the tropical seas south of 23° north latitude.

(b) Schools which make a great circular migration in the northern Equatorial Current when it is at its height in the spring and summer.

(c) Schools which move north and south in the Kuroshio.

It is, of course, difficult to make a hard and fast distinction between these three systems and they appear to fluctuate with natural changes in the oceanographic conditions. The schools in system (a) are shoal-fish or island-fish with a limited range of movement, and they have a tendency to stay in one place. Systems (b) and (c) comprise the so-called migratory stock. Their range of movement is broad, and in the course of their great migrations they respond to variations in objective factors such as currents, water temperatures, character of the sea water, food, and so forth. They may adopt various patterns of migration such as taking on tendencies similar to those of system (a) and remaining throughout the year on reefs and shoals or around islands in the Satsunan and Zunan areas, or turning south midway in the migratory path of system (c) and failing to reach the Northeastern area. The schools of system (b) are the main element in the skipjack of Japanese waters and the presence or absence of these fish determines the year to year success of the skipjack fishery.

1, The make-up of the skipjack population in Japanese waters

Investigations in all areas have revealed that the fish which are taken in Japanese waters are mainly 4 to 5 years old and that the peak seasons come every four years.

Skipjack are classified by weight, those above 1 kan [8.27 lbs.] being called large skipjack, those from 500 to 1,000 momme [4.13 to 8.27 lbs.] medium skipjack, and those below 500 momme small skipjack. Investigations in various areas show some variation from year to year, but the overall picture is generally as follows.

(1) Satsunan area

Schools of small skipjack appear around March and are most numerous from April to August. They make up about 50% of the skipjack schools which appear in this area, and also account for the greatest part of the catch. The schools of medium skipjack are mingled with the schools of small fish in March and reach their greatest abundance in April and May after which time they decline in numbers. They reappear again in August and September, but in this area they form the smallest element in the skipjack population and in the catch, being only 20% of the total. Schools of large fish appear and are taken in the greatest numbers from April to August. They form 30% of the total catch in this area. Thus in this area schools of young skipjack are the most important, followed in order by old and middle-aged fish, which are thought to be shoal-dwelling schools.

(2) Kinan area

This area is in the path of migration of the schools and the length of time they remain in the area is extremely short. From the latter part of March to the middle of May the number of schools which appear and the catch ratios are extraordinarily small in comparison with other areas. Small fish (60%) make up the greater part of the population, followed by medium fish (40%), and almost no large fish appear in the area.

(3) Zunan area

Schools of small skipjack increase in numbers progressively from April on and reach their peak around July after which time they gradually decrease. In this area schools of small fish make up 35% of the total. Medium fish appear in these waters at the same time as the small fish and for a time comprise 80% of all schools. They increase until about July and thereafter decrease to 55%. Schools of large skipjack come in from May to July and form about 10% of all schools. Note: It is thought that actually the ratio of schools of large fish should be increased somewhat because few fishermen fish these schools.

(4) Northeastern area

The schools of small skipjack appear in this area in May and remain until around September, but their number gradually diminshes. They make up 5% of the schools in the area. It is thought that during this period quite a number of them grow large enough to enter the medium skipjack category. Medium skipjack along with small skipjack make up the bulk of the fish in this area, and they gradually increase until they reach their peak in June and July after which they decrease. In these waters they comprise 75% of all schools. Schools of large fish are still very scarce in May and gradually increase from July to September, but these are thought to include fish which grew into the large category in these waters as well as fish which were large when they entered the area.

To summarize the facts which have been given above for each of the several areas, the skipjack schools which enter Japanese waters are principally medium fish, these occupying 60% of the total. In the Northeastern and Zunan areas they are remarkably abundant, while in the Kinan and Satsunan areas the schools of small fish predominate, forming 30% of all schools. Large fish are comparatively abundant in the Satsunan area, but they form only about 10% of the total population. Table 2 shows the distribution of the total skipjack population by areas.

Table 2

Area	1937	1938	1939
Northeastern	66%	62%	59%
Zunan	11%	13%	10%
Kinan	13%	10%	20%
Satsunan	10%	15%	11%

2, Migration routes of the skipjack schools

The migrations of the skipjack are controlled by the instincts peculiar to the fish and by the condition of the ocean currents. There is one great migration, as described above, but it takes place along the following routes.

(a) Along the Northern Equatorial Current past the Philippines, Taiwan, and Okinawa to the Satsunan area and thence gradually northward.

(b) From the South Seas area to the Zunan area along the northerly warm current of the Kuroshio which originates in the waters near the Bonins in the spring.

(c) Northward between the Northern Equatorial Current and the northerly warm current of the Ogasawara region to the vicinity of the Kinan reefs in the Kinan area (30° 10' North, 136° 45' East).

These three are assumed to be the routes of migration. These schools of skipjack show a tendency to concentrate gradually in the Northeastern area as the power of the Kuroshio increases from May to July. In the latter part of April and the early part of May they congregate in a radius of 150 to 300 miles southeast of Nojima Saki (Chiba Prefecture). Then these schools move to the northeast and proceed north as the water temperatures rise. Every year in the middle and latter parts of July they reach the area 150 to 200 miles east of Kinkasan (Miyagi Prefecture). Further northward movement of the schools is barred by the pressure of the Oyashio, and they remain for a comparatively long time in these waters. In September they reach the northern limit of their migration which, depending on the year, may be as far north as the waters adjacent to the Kuriles, that is, the vicinity of Etorofu I. and Shikotan I. Thereafter as the Oyashio increases in strength the schools turn southward and move south comparatively far out to sea, over 300 miles off shore, returning to their native South Seas by way of the waters of the Zunan area.

In the Amami Oshima region of the Satsunan area, the schools appear around the early part of February and are most numerous from the end of February to around July. After that time they gradually decrease in numbers and disappear about December. Most of the schools in this area come up from the south and remain in the area. Some of them take up residence around the reefs and become the so-called "sedentary fish", some part of them continue north, and the rest return to the south in the autumn.

The schools which appear in the Kinan area are most numerous around May, their numbers diminishing remarkably in the latter part of June. Possibly they move north into the Northeastern area. The schools of the Zunan area put in their appearance first in the vicinity of Torishima and are most numerous in May and June. Thereafter they divide into schools which migrate north into the Northeastern area and schools which remain from summer to autumn in this area. A number of schools returning southward from the Sanriku area are also seen in the Kinan area during October and November.

3, Conditions which regulate the migrations of the skipjack schools

The migrations of the skipjack schools are premised upon the strength or weakness of the Kuroshio. The water temperatures in the Kuroshio begin slowly to rise in early February and reach their maximum around July and

early August. After that time they gradually fall. This rise and fall in the water temperature is a necessary condition for the migration of the skipjack. When the temperature of the Kuroshio changes in this regular fashion, many schools inhabit its waters and the period of their stay in Japanese waters is prolonged. When, on the other hand, the temperature rises and falls irregularly or changes abruptly, the migrations of the schools also become irregular, and although many schools may be seen in certain localities, the migration as a whole often turns out to be of a low volume.

On the whole the factor which controls the migrations of the schools is the temperature of the depth at which the fish live. Favorable temperatures of the surface water are within the range of 19° to 26° C. There is naturally some variation depending on the area, the range in the northern part of the Northeastern area being 20 - 21°, that in the southern part of the same area 22-23°, Zunan area 23-25°, Satsunan area 24-26°. The migrations are predicated on the regular appearance of the usual temperature for the season in each of the areas, the water color, chemical composition, and so forth being incidental conditions.

Section 3 Bait

In skipjack fishing the first thing to be taken into consideration is the choice of a bait. The use of a suitable bait is the most vital factor in this fishery. As set forth in the preceding pages, the skipjack is hatched and grows up in the South Seas and comes north on a migration in search of food. In general when fishes from the South Seas go north, they tend to seek foods which resemble those to which they are accustomed in the South. This probably is instinctive in the fish. The following is an account of the foods found in the South Seas area.

(a) tarekuchi iwashi [probably Engraulis heterolobus Rüppell] -- The body is flattened laterally. The fish occur in shallows where the water is less than one fathom deep on coasts where fresh water enters the sea and where mangrove trees grow densely in the vicinity. They school together with the maiwashi.

(b) maiwashi [may be Harengula moluccensis Bleeker] -- About 3.6 inches in length, they concentrate in the shade of trees along the shore. Those which occur near shore are particularly flattened laterally. The oba iwashi, which are 4.8 to 6.0 inches long, are not seen along the shore but occur in deep water. They differ somewhat from the maiwashi of Japan.

(c) urume iwashi -- They do appear along the shore but are found in waters of about 10 fathoms depth. The head resembles that of the barracuda, the body is silvery, and the eye is large. The flesh is white and soft, and the fish are hard to keep alive.

(d) shirotare iwashi -- The shape of the head resembles that of the tarekuchi iwashi, but the fish is white and has one golden stripe along its sides. This species is not seen near shore in shallow places. It forms dense schools and is suitable for use as bait. The scales are thin

and easily come off. The body is soft and weak, and although it is all right for chumming bait, it is not suitable for baiting hooks and is difficult to keep alive.

(e) kihiko iwashi -- Like the maiwashi in form with small scales and a pointed head. Those about 2.4 inches in length come in close to shore in about two or three feet of water. They are suitable for bait, but cannot be taken in large quantities.

(f) shirozako iwashi, akazako iwashi -- The shirozako iwashi is white and is from .96 inch to 1.2 - 2.4 inches in length. The akazako iwashi is pale red and usually about 2.4 inches long. Both are rather translucent so that their flesh and skeleton can be seen through their skin. They live around coral reefs in depths up to 7 or 8 fathoms, and come out of the holes in the reef at night to search for food.

(g) baka iwashi -- This is the principal baitfish in Saipan waters. It attains a length of from 1.2 to 2.4 inches.

(h) shiira -- This fish resembles the young of the hiraiwashi of Japan. Its body is long and slender and it is abundant around Saipan.

(i) hiraaji -- The young of the meaji [probably Trachurops crumenopthalma (Bloch)]. It is much larger than the shiira, seven fish weighing about 100 momme [13.27 ounces]. They are very good as bait for medium and large skipjack.

(j) muroaji -- Similar in size to the hiraaji, these fish are suitable as bait for medium and large skipjack.

(k) akamuro [probably Caessio chrysozoma (Kuhl & Hass)] -- About 3 inches long. They occur in large schools, are suitable for bait, and are easily kept alive.

(l) sanera [p- aps a caesionid or apogonid] -- These fish congregate on the bottom outside of the reef in depths of 12 to 16 fathoms and are about 1.8 inches long.

In addition to the above, the skipjack's diet includes the aohige, a kind of itoyori [Euthyopteroma sp.?], ojisan, takabe [a pomadasid?], shimaw ro gurugun, tobugoro, kibinago, dogoro iwashi [Atherina valenciennesii Bleek r ?], and others.

These small fish provide food for the skipjack schools in the South Seas area, and as a result, the older they become the more accustomed they are to these types of food. Consequently even during their migrations they necessarily seek the same kinds of food. This gives some indication as to the bait to select for skipjack fishing in Japanese waters.

When schools of skipjack which have grown up on this sort of food come into Japanese w s, what sort of things do they eat? If we examine the stomach contents of the skipjack which are taken, we can answer the question as follows.

Sardines, anchovies, mackerel, mackerel-scads, myctophids, flying-fish, squid, Ryūkyū squid, shrimp, spotted shrimp, larval crabs, schizopods, and amphipods. Quite a few fish are found to have completely empty stomachs.

The state of the balance between the total population of skipjack in Japanese waters and the available supply of natural food as well as the factors which led to the establishment of the skipjack fishery are believed to be implied in these facts.

The following deductions can also be made from a consideration of the skipjack's food habits. Schools which feed on such things as mackerel, mackerel-scad, spotted shrimp, larval crabs, and amphipods, all of which are of a coastal character, are composed of "sedentary fish" or fish which have stayed temporarily around islands, reefs, and shoals. The schools which feed on pelagic forms such as flyingfish, squid, and schizopods are those which are accustomed to swimming in the open sea. Schools of fish which have empty stomachs can be assumed to be pelagic schools which have not been able to find food before being taken.

Section 4 Characteristics of the Skipjack

Paragraph 1 The Skipjack's Eyes

According to Mr. Shigeo Yamamoto's report of his researches, "The study of the refraction characteristics and accommodation mechanism of the eye of the skipjack reveals the following facts. Judging from the fact that the crystalline body in the eye of the fish is almost spherical, it has been said in the past that the fish are near-sighted, but this study has revealed that they are on the contrary far-sighted, very much so in fact. This has been established in the case of the skipjack, tuna, sea-bass, and striped marlin. If we measure the crystalline body's refraction of parallel rays of light in the air, we find that it has a very short focal distance of only 0.4 mm, however, if we measure it for the skipjack in the water with a piece of glass fastened behind it [?], we find that it has a long focal distance of 15 mm, differing markedly from the visual line of about 6 mm. This places the focal point about 7 mm behind the retina of the eye, and means that the eye is far-sighted. This is thought to be the condition when the eye is at rest, and it is assumed that it is so constructed as to be capable of even stronger far-sight. The fish can see clearly at least 30 or 35 feet ahead, but of course it is impossible to see as far in the water as in the air, no matter how far-sighted it may be, because the water contains more fine particles than the air and the sun's rays are weaker in the water. The eye muscles of the skipjack, like those of terrestrial mammals, include the superior direct, inferior direct, inferior oblique, external direct, and internal direct muscles, but great differences are apparent in their size and points of insertion. These muscles not only move the eyeball forward and backward and up and down, but they appear also to contribute to the adjustment of the vision ... A statement of the conclusions based on the results of the study would indicate that the skipjack does not have very good vision obliquely to the rear. When relaxed or at rest, all of the eye muscles are resting,

the eyeball is flush with the spindle-shaped surface of the head (at an acute angle to the center line of the body), and both eyes are directed somewhat forward. At such times it can be said that the eyes are a bit more far-sighted than when the vision is directed to the sides or obliquely to the rear. This means that when fishing it is ineffective to throw bait close to the sides of the body. The superior direct muscle and the superior oblique muscle are stronger than the corresponding inferior muscles, and because of this the skipjack's eye can more easily be turned upward than downward. Consequently it is thought that the fish cannot see very well below the level of its body. Since the upper forward edge and the lower rear edge of the eye socket have concavities, it seems that visual power is especially great to the upper front and the lower rear. The field in which rather far vision is possible lies from obliquely ahead to straight ahead of the body, and vision must be best along a prologation of the center axis of the body. Because the pupil of the skipjack's eye is large and ellipsoid in shape its field of vision both ahead and to the rear is much greater than that of the human eye. When the skipjack strongly contracts the internal direct muscle, the eyeball is directed obliquely forward, the line of sight is shortened, the convexity of the crystalline body is somewhat decreased, and the vision becomes remarkably far-sighted. Depending on the clarity of the water, it appears that the vision extends to [illegible] yards of 60 feet. As a result of having such powers of sight the skipjack can swim at speeds of 60 to 70 knots per hour without colliding with anything and can swim about in large schools. They can also, relying partly on their instincts, surround large schools of sardines. It is entirely due to its excellent eyesight that the skipjack can be readily taken by fishermen. That is to say, it is because the skipjack is far-sighted that it can see the chumming bait from a distance, and when it comes in close in order to take the bait, it becomes unable to distinguish the artificial lures from the live bait. If artificial lures are used when the fish are being attracted from a distance, they are ineffective because the fish have good enough vision to distinguish them. Such lures should be used after the skipjack have been brought in close. The practice of spraying water while fishing with pole and line gear is also based on this characteristic of the skipjack." Fishing methods should be thoroughly thought out in order to take advantage of the skipjack's far-sightedness.

Paragraph 2 Swimming Characteristics

(a) Shark-associated skipjack, whale-associated skipjack--These are skipjack schools which follow the lead of kambeisame [basking sharks?] and sardine whales. The sharks and whales are wily enough to steal the sardines which the skipjack round up for food, but the skipjack can thus take refuge far out at sea from the striped marlin which attack their schools, so it is a kind of cooperative living in which the skipjack and the sharks and whales mutually help each other. This phenomenon is often seen in the Northeastern and Zunan areas.

(b) Driftwood-associated [illegible] schools are most often seen in the Zunan, Kinan, and Satsunan [illegible]. These are schools which swim along with a drifting log. (Logs which float vertically are more favored than those

which float horizontally and the older and more covered with barnacles, amphipods, and so forth that they are, the better.)

(c) "Calm ones [tairamono]" -- Schools engaged in this type of behavior are often seen in the Northeastern area. The fish surround some schizopods (like the mysids) and lie on the surface gently moving their tails and eating their prey. The surface of the water where such a school is feeding is quite smooth with only small ripples disturbing it.

(d) "Bait-bed [sodcko]" -- This is the term applied when a school surrounds a school of small sardines, drives them into a compact mass, and greedily eats them.

(e) "Sleepers [toromi]" -- This term is applied to schools which leisurely swim around a concentrated school of bait in a state of exhilaration as if they were drunk.

(f) "Jumpers [kane]" -- Schools in which the fish chase the bait around independently, showing themselves at the surface of the water and keeping no regular formation.

(g) "Silver flow [ginnagashi]" -- Schools which, perhaps because they have eaten their fill or perhaps because they are in a playful mood, swim slowly turning frequently on their sides and flashing silver. Such schools will hardly ever take chum-bait. This is a condition often seen between Nojima and Kinkazan.

(h) Resting skipjack -- Schools are in this condition around August. They swim about and refuse to take chum-bait.

(i) Ascending skipjack -- These are the northbound schools. They swim comparatively near the surface.

(j) Descending skipjack -- Schools returning southward in September and October. They swim deep and fast.

(k) Roving skipjack (deepsea fish) -- These are schools which swim out in the open sea. The fish in the Northeastern area are almost all of this type. They are mainly medium-sized fish, and they are fat. They move following water temperatures of 20 - 24°C.

(l) Sedentary skipjack (shoal fish) -- Schools which stick close to banks (reefs) and islands. They are mostly submerged in the lower levels and hardly show themselves except at certain tides or in the morning and evening. Shoal fish in the South Seas area are either over 1 kan [8.27 lbs.] in weight or under 500 momme [4.14 lbs.]. They occur in water temperatures as high as 26 - 30° C. Suitable depths on the fish banks are about 150 meters. The fish are comparatively lean.

(m) "Tsukkakari fish" -- Same as dekiuo [adventitious fish]. Fish which are submerged below the surface and which come up a few at a time to take the chumming bait. A rather dense school will occasionally come up.

(n) Namura -- A general term for surfaced fish. Skipjack schools which swim about in the open sea are called skipjack namura.

(o) Bottom namura -- A term applied to skipjack schools which swim submerged below the surface.

These are the characteristics which skipjack fishermen in all localities have since ancient times considered important not only for the finding of schools but also for catching the fish. There are various local dialect names applied to the same single phenomenon. These terms have been used from ancient times to the present day without ever having been standardized.

Paragraph 3 Other Characteristics

(1) Bait-taking characteristics

Skipjack are by nature averse to eating dead food. This means that they cannot be taken unless live bait is used. However, old fish which have lost their migratory powers and which drift about in the sea together with the albacore wherever the currents may carry them occasionally do take dead bait.

(2) Predators of the skipjack

They are pursued by the striped marlin and the okisawara [Cybium chinense].

(3) Vertical movements of the skipjack

It is naturally characteristic of the skipjack to swim in the surface layer of the ocean, but, perhaps to avoid the attacks of predators or perhaps in order to search for food, they prefer to swim below the surface except when they are feeding. They also come up to the surface when plankton are present there, in the dim light of dawn and evening, and when the tide creates rising currents. When the movement of the tide ceases, the skipjack which are at the surface tend to submerge. This tendency is especially characteristic of the schools of sedentary skipjack.

The time of surfacing for "roving" skipjack too is from dawn to about 8:00 a.m. and from about 2:00 p.m. to sunset. They do not surface very much during the middle of the day when the sun's rays are strong. Schools which on rare occasions do come up at such times are "playing" fish and will not take the bait. Around August when the sun's rays are strong and the water temperatures rise the surfacing and feeding activities of the fish become dull and this is said to be the dog-days vacation of the skipjack.

Within the range of habitable water temperatures of the sea areas in which they dwell, skipjack tend to prefer areas of comparatively high temperatures in the spring and low temperatures in the fall. There are also local peculiarities caused by special characteristics of the

fishing grounds, currents, and so forth which are limited to the schools inhabiting those localities.

@ In what sort of waters are skipjack found?

@ Why do the skipjack migrate?

@ Where is the original home of the skipjack? Why do they return there?

@ What do the skipjack eat?

@ What routes are followed by the skipjack which come to Japan?

@ How do the skipjack fishermen divide up the fishing grounds for convenience' sake? What names are given to the divisions?

@ Fish are said to be near-sighted, but is this also true of the skipjack?

Chapter III

The Skipjack Fishery

In putting a skipjack fishery into operation the first essential is to understand clearly the habits of and other facts about the fish. What it has been possible to learn about the skipjack's habits is actively made use of in the fishery, and methods are devised to take advantage of the weak points of the fish. The thing to do is to direct the main force of one's attack toward the weak point of one's opponent and at one stroke attain success in fishing. In Chapter I we traced the changes in fishing methods from ancient times to the present day, provided materials for criticising them, and discussed features which should be corrected. In Chapter II we considered the nature of the skipjack and discussed the rationality of the old methods of operation in the skipjack fishery in order to give some indications of the course to be followed in the future.

The author, who has presented the foregoing material as data to be used in understanding the character of the fishery in its present advanced state, feels that there is still a necessity for criticism and discussion of some of the basic premises. To be specific, these are the characteristics of the skipjack fishery.

(1) The skipjack fishery has been spread all over the country, and in each locality it has its own peculiar history. As a result, studies of all sorts were made in each region separately, conclusions were drawn, and the people in these areas believe in those conclusions and identify themselves with them. The fishing grounds have been epochally extended, but people will not lend an ear to conclusions based on the combined

scientific data gathered from these broad sea areas, nor will they have the broad-mindedness to agree with these conclusions; they thoughtlessly stick to their old customs and still carry on their conservative operations. To put it bluntly, the conclusions of the past were derived from operations in an extremely limited area and they are already inapplicable to operations in the broad areas of today's fishery.

(2) The skipjack fishery depends on the skill of individuals. At the present level of dissemination of practical fisheries knowledge it is difficult to expand a fishery which depends on individual skill, and the development of such a fishery follows an irregular course. It is difficult to bring about an overall improvement in catches, and the situation gives rise to marked inequalities in fishing success.

(3) Under present conditions in Japan the area of operation is restricted and limited to the waters within the MacArthur Line. It is difficult to get data with which to assess the situation, and one cannot hope to determine in advance the appropriate policies to be followed in any particular year's fishing. For the most part each fishing boat has to rely on its own good or bad luck.

(4) This fishery, in comparison with others, can get by with very little materials. Consequently it is an enterprise most suited to the present conditions of supply in Japan, and is the easiest field of enterprise to enter, with the result that the concentration of new entrepreneurs in it has brought about somewhat disorganized conditions.

Section 1 Fishing Gear

As explained above, the skipjack fishery has followed its own particular course of development in each area and has relied on the skill of individuals. As a result there are many local peculiarities, but the essentials of both gear and methods do not differ greatly.

Paragraph 1 Pole and line gear

1, Poles

The material is chiefly long-jointed bamboo produced in the locality where it is used. Gosan bamboo, hatake bamboo, and karatake bamboo are widely employed. Requirements for skipjack pole are (a) that the bamboo be straight and that there be no danger of its breaking, (b) that it be stiff, and (c) that the elasticity of the tip be great.

The dimensions of the pole should be such that it will be thick enough for the user to grasp it firmly with one hand and not too heavy for him to manipulate easily. Strictly speaking, the size of the pole is determined by the strength and skill of the fisherman, and generally skipjack fishing poles are selected and prepared by the fisherman himself. The usual standard for poles is 18 - 20 feet long with a diameter of 1.44 to 1.8 inches at the butt and 0.6 to 0.96 inches at the tip. In some localities the dimensions of poles used for bait fishing are different

from those used with artificial lures. The latter are somewhat slenderer and about 15 - 16 feet long so that they can be managed more dextrously.

The butt of the pole is wrapped with string to provide a firm grip. This twine is of hemp, iwaito [?], or cotton of about size No. 20, and it is wrapped around the pole at from five to seven places to the width of about 0.6 inch and with about the same space between wrappings. This part of the pole is called the grip [nigiri or tedoko]. While the pole is not in use the hook is stuck into these wrappings to prevent the line from tangling. A thick wrapping of strong hemp twine is put on the tip to form a snake's mouth (pot) [loop] to which the fishing line is fastened. The method of making this knot varies with the locality, but the essential thing is that it be tied tightly so that it will not slip and that it will not make the manipulation of the pole unnatural.

2, Fishing line

As a rule the line is 1 to 1½ feet shorter than the pole. It is divided into a main line and a leader. The former is sometimes called takayama and the latter koyama. (Yama is a dialect form of yoma meaning string.) Different materials have been used in different localities and at different periods. The following are two or three examples of the present practice.

(1) An example from the Northeastern area (see Fig. 6).

The main line is 11 feet of iwaito .084 to .096 inch in diameter. The leader is 1 foot of three-strand righthand twist wire, one end of which is fastened to the hook while the other end has an eye for attaching it to the line. The main line and the leader are joined by a piece of No. 12 cotton line one foot in length which is doubled and twisted to the left with an eye in one end and a knot on the other.

(2) An example from the Kagoshima area

The main line is made of high-grade hemp, .36 inch in circumference, three strands being twisted together, or it is made of high-grade hemp served with No. 50 - 100 cotton line, the finished line being about .36 to .42 inch [in diameter?]. The leader is from 9.6 to 10.2 inches long and one end is fastened to the hook. The material is No. 28 or 29 wire (about the same size as No. 22 cotton line), three strands with a right-hand twist, and both ends are served.

(3) An example from the Shizuoka area

The main line is kanabiki [?] hemp, hand-twisted with two strands, diameter .36 to .48 inch, length 12 to 16 feet, undyed. The leader is the same material and the same size as the main line but is dyed indigo.

(4) An example from the Chiba area

The main line is home-made from high-grade Nōshū hemp. It is about 18 feet long, two strands with a left twist, and is undyed. The leader is

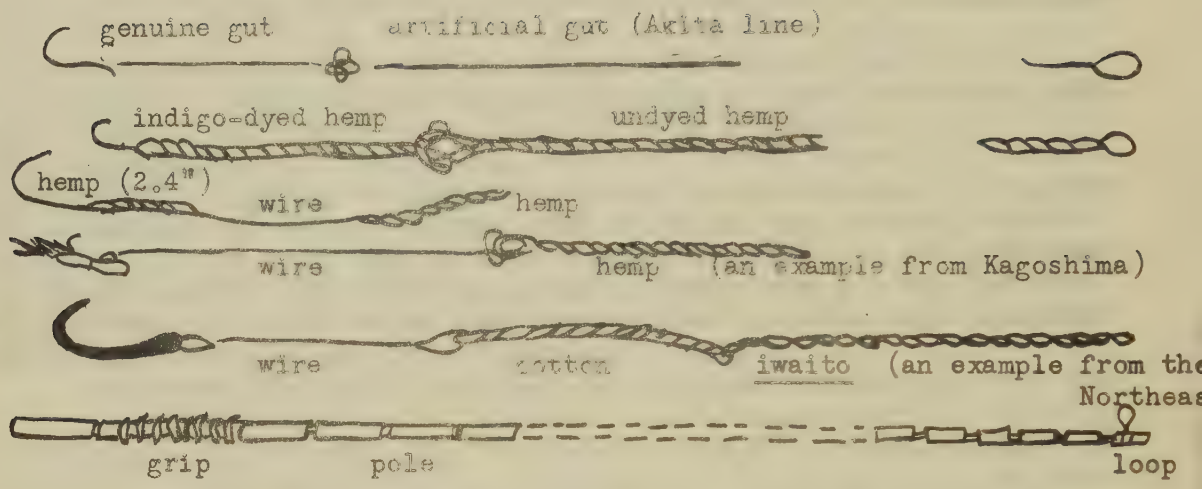

Figure 6 Poles and lines

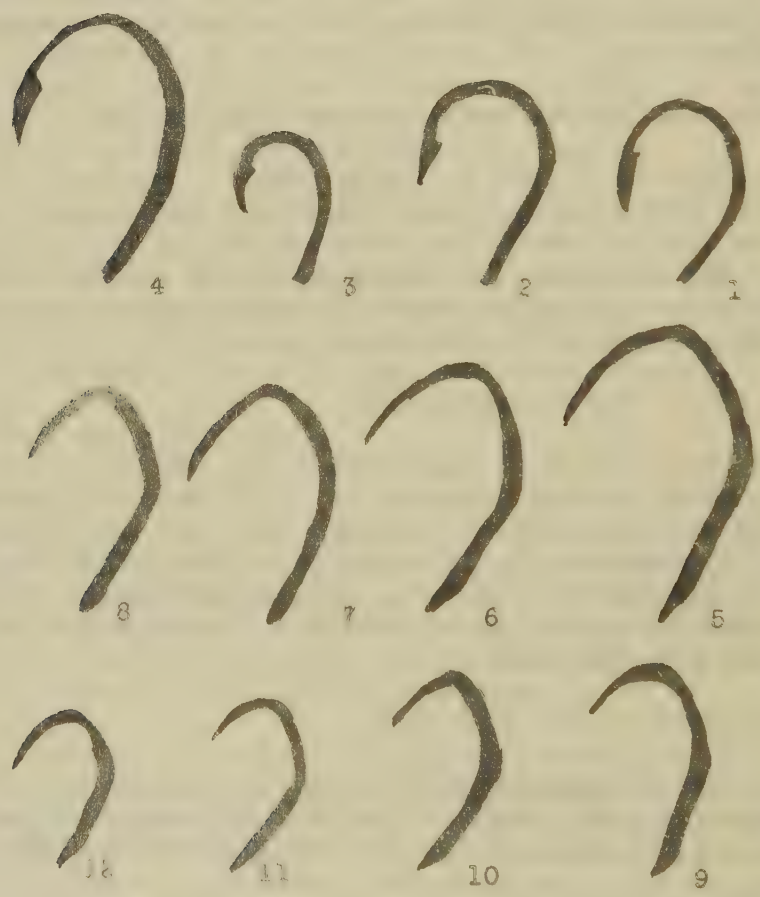

Figure 7 Skipjack hooks (actual size)

1 - 4 Tosa Tankichi type, 5 - 12 ordinary skipjack hooks

made of high-grade Hikita hemp dyed indigo, with two strands loosely twisted to the left. It is about 13 inches long. Instead of hemp for the main line some fishermen use artificial gut of 8 to 9 momme weight [1.06 to 1.19 ounces per five-foot fathom], with No. 28 or 29 cotton for the leader.

(5) An example from the Kōchi area

The main line is high-grade Nōshū hemp, two-strand, righthand twist, diameter .06 to .096 inch, length 12 to 16 feet, undyed. The leader is made of the same kind of hemp either dyed with indigo or made of a mixture of undyed and indigo-dyed hemp fibers. It is two-strand, righthand twist, and from 1 to 1.2 feet in length. The thickness depends on the size of hooks to be used, ranging from .018 to about .096 inch. In some exceptional cases the leader is served.

The above data on the materials used for skipjack fishing lead to the following conclusions.

(1) Not much attention is paid, as in other types of angling, to the fineness of the line, strength to withstand the skipjack's vigorous strikes being more sought after, and therefore material which is unlikely to break is chosen. In order not to alarm the fish, the leader, the part of the line which is in the water, is dyed with indigo to the same color as the waters of the Kuroshio. This practice has been carried on since rather ancient times and has spread all over the country, for which reason it is thought that it must be fairly effective. There is a need for further investigation on this point.

(2) The fishing line is replaced constantly during the fishing season so that it will have its maximum tensile strength at all times. The work of hooking fish is very violent so a great strain is placed on the line and excessive force is applied to it. When the school is large, the operation continues for a fairly long time during which the fishermen must bring in as many fish as possible. To make sure that the line does not break during this time they change the leader frequently, keeping a supply of spare ones handy. The main line will last for about ten days of fishing. The leader needs to be strong enough to stand up under a whole day of use, no matter how many fish may be caught during the day. The best material is one which, even though it may weaken considerably when soaked with water for a long time, can be unconditionally guaranteed for a short period of time. On this score hemp is the most suitable. The use of wire for leaders is not a question of strength or weakness, but rather of what will catch the most fish. Aside from the effect on the catch there is no pressing reason for using it. In fact wire which is not completely rustproof probably has an adverse effect on the catch. In the last analysis this is a point which should be investigated on the basis of the catch ratios.

(3) The question of what kind of fishing line is best has hitherto been taken up only from the point of view, not of the effect on the catch, but of how a hooked skipjack could be got into the boat without being dropped, in other words, only the strength of the line was considered, and the

fishermen have tended to ignore the question of what effect the thickness and color of the line may have on the schools. In other words, the type of fishing line used in the past indicates that it has been easy to catch skipjack.

(4) Lately the fishermen have come to the point of considering the effect of the line on the school as well as its strength. In order to keep the strength of the wire and hemp which have been used in the past and at the same time to reduce the thickness of the line and to get a clear material which will do away with disadvantageous color and sheen in the water, they are using mostly artificial gut for the main line and high-grade genuine gut for the leader. Nylon line and other new materials are also getting some attention. Impetus has been given to this movement by the postwar expansion of the skipjack fishery and the entry into it of newcomers who do not have the skill and experience and who have not been accustomed to making their own gear. As a result a wide variety of materials other than those used in the past are being popularized, however, because of the high price of some of these materials and the difficulty of obtaining them at present they have not yet come into universal use.

3, Hooks

Two types of hooks have been used since ancient times for skipjack fishing. They are bait hooks and squid hooks [artificial lures]. The skipjack hook is characterized by its lack of a barb, and where a barb is present it is merely a vestigial small bend in the tip of the hook. This peculiarity is related to the habits of the skipjack, is revelatory of the peculiar character of the fishing operation, and is a reason why the skill of the individual fisherman is emphasized. There is some variation depending on local tastes.

(1) Bait hooks

These hooks are either of the round type or a compromise between the round type and the angular type. They have no barb (although some have a vestigial one), and the space from point to shank is broad. Sizes from .96 inch to 2.76 inches are used. Materials are either steel or tempered iron and in both cases the hooks may be either tin-plated to give a bright finish or they may be burnt black. The size of the leader is varied to suit the size of the hook.

The size of the hook which is used depends on the size of the skipjack being fished (depending on the season) or on the size of the bait.
(a) medium skipjack (under 1 kan [8.27 lbs.]) -- The hooks used are chiefly 1.32, 1.44, or 1.74 inches in size.
(b) large skipjack (over 8.27 lbs. weight) -- The hooks used are 1.8, 2.04, 2.28, or 2.52 inches in size.

When anchovies 1.2 to 1.8 inches in length are used as bait, the hooks used are less than 1.74 inches in size. When the bait is herring, anchovy, or sardine from 1.8 [illegible] inches in length, the hooks are of sizes smaller than 2.4 inches. When sardines or mackerel-scad 3.6 to 4.2 inches in length hooks of about the 2.4-inch size are used. The design is different

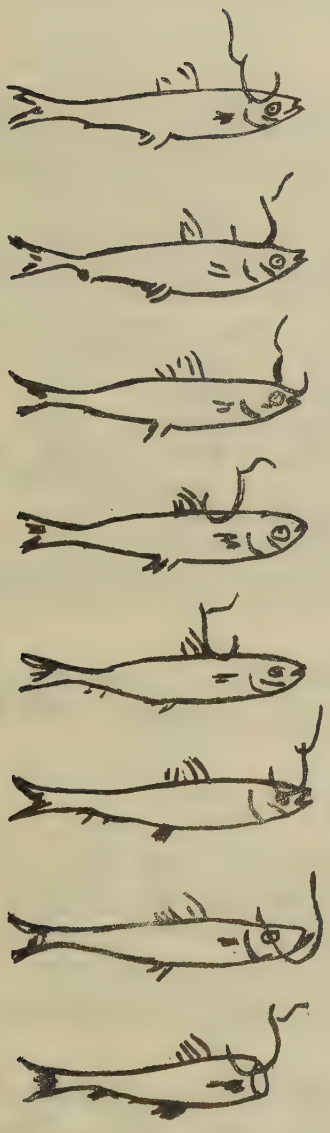

Figure 14 Methods of baiting hooks

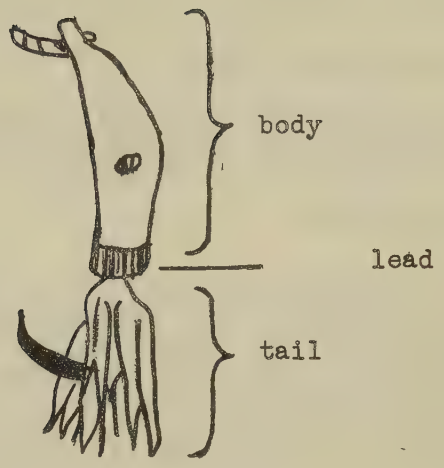

Figure 8 Horn lure

Figure 10 Feather lure

in each locality. Until the war the nationally famous Tankichi hooks, which, as shown in Figure 7, have traces of a barb, were manufactured.

(2) Artificial lures

These have been widely used since ancient times, with excellent results, and there are many varieties of them.

(a) Horn lures

These are composed of the "mae" [body of the lure] and the "eba" [tail of the lure] (these are the terms used in the Kagoshima area). The body of the lure is made of cow horn, water-buffalo horn, deer horn, goat horn, whale bone, spearfish spears, ivory, and so forth, and a round-type barbless hook is inserted in it. Then to make the whole thing look like a squid the belly skin of a tetraodont or some feathers are tied on. This tail is made long enough to fully cover the point of the hook. With the whole lure from 3.36 to 3.6 inches long, the body of the lure will be about 1.44 inches long and about 0.6 inch in diameter, and the tail will be from 1.8 to 2.16 inches long. It is thought to be effective to inlay the body of the lure with various types of shell. Abalone, white pearl shell, black pearl shell, tataki shell, roppo shell, shabo shell, tarashi shell, and Cnrysocroa elegans are used for this purpose. The effectiveness of horn lures varies depending on the type and coloring. In general it appears that either red or black is best. It is said that red ones are good in clear water while black ones are good in either clear or turbid water.

The poles used with horn lures are male bamboos with a strong mid-section and a flexible tip, the tip being .24 inch in diameter, and the line is about 4 feet long.

(b) Feather lures (bake, buppai, or sawakagura)

These lures have tin fitted to the base of the hook and the point covered by white feathers and white or black fish-skin. The overall length is about 1.8 inches. The tin is about .24 inch in diameter and the hook is cast into it. Feathers and quills are tied to it; sometimes brass tubing is used around the tin, and the lures are made in many different shapes.

With these lures poles which have a strong mid-section and a flexible tip are used. The same line is used as when fishing with bait. These lures are chiefly employed when the skipjack are biting well. They are held in the water so that the upper end of the lure is one or two inches under the surface and then the tip of the pole is agitated. When a skipjack is hooked, it is scooped up in a dipnet.

(c) Jigs [shaburi] (trolled feather lures)

This type of lure is made to resemble a squid. It consists of a flat piece of lead about 3 inches long and .48 inch wide or a cylindrical lead about 1.2 inches long by .3 inch in diameter to which six or seven

feathers or long narrow strips of balloonfish skin are fastened. Most of these hooks have barbs. On the fishing grounds they are trolled from the stern of the boat on 20 to 50 fathoms of line. If they take a skipjack on this gear, the fishermen judge that there is a school in the vicinity and begin fishing. They are employed particularly after the latter part of September when the schools go deep and become permanently located on the shoals. There are also many types of these lures.

Paragraph 2 Bait

As set forth in the section on the habits of the skipjack, the conditions which govern the use of bait for skipjack are that it be live-bait and that it suit the skipjack's taste. Furthermore, fishes which meet these requirements must also be easily taken in waters close to Japan and they must be available in large quantities in a live state. At present the various kinds of iwashi are used for the most part.

1, Baits used in skipjack fishing

(a) Engraulis japonicus [?] -- This species is preferred by the skipjack boats in the Kagoshima, Shizuoka, Chiba, Ibaragi, and Fukushima regions.
(b) Decapterus muroaji -- Used in the Tokushima and Chiba areas.
(c) Sardinia melanosticta -- Used almost all over the country, it occupies the first place for quantity, but the main areas of use are Kagoshima, Kōchi, Chiba, Miyazaki, Iwate, and Kumamoto.

(d) small mackerel-scad -- Kagoshima, Miyazaki, Tokushima, and Mie areas.
(e) small mackerel -- Kagoshima, Miyazaki, Tokushima, Kōchi, and Iwate areas.
(f) iwashi -- Kagoshima, Miyazaki, Tokushima, Wakayama, Mie, Kanagawa, and Aomori areas.
(g) small skipjack -- Miyazaki area
(h) mackerel, mackerel-scad -- Miyazaki area
(i) anchovy [katakuchi iwashi] -- Kōchi area

In addition to these species, mysids and living larval fish and eels are used for chum bait.

2, How bait iwashi are kept alive

Live bait is the animal in its natural living state, and in many cases it is the best type of bait. When baits other than live bait are used, it is extremely difficult to catch fish; since ancient times live bait has been used almost exclusively and it has been easy to take fish with it. Because the bait fish are in their natural living state it is necessary to use the greatest care in keeping and transporting them, and even then they occasionally will die.

As the skipjack season approaches, bait-pounds are set up at the baiting grounds, commonly called esaba, which are usually places inside

bays where the waves do not come directly in from the ocean. These pounds are made of palm fiber netting with a fine mesh. The meshes are very small so that iwashi 1.2 to 2.4 inches long will not get stuck in them, and the water circulates well through the net providing a thorough natural changing of the water which is a requisite for holding bait. The size of the pounds varies, there being no particular standard, but they are commonly about 9 feet by 9 feet by 6 -- 12 feet. They are made with wooden frames over which the web is stretched like a bag. These pounds are set out in the water in large numbers for the purpose of keeping bait.

(1) The capture of iwashi for bait

Various types of gear are used, each locality having its own peculiar gear. There are some types of gear which are specialized for use in taking iwashi for bait, and in other cases gear designed for other fisheries is used as convenient.

One of the kinds of specialized gear is a small-scale set net (commonly called a crystal net [suishōami] or machine net [kikaiami]) which is set in bays across the paths of migration of the iwashi as the skipjack season approaches. Iwashi which enter the heart of the trap are carefully taken out with dipnets in such a way as not to injure or weaken them and are placed in bait scows or live-pounds. They are then kept in the live-pounds in quiet waters as described above. Iwashi which enter large trap nets and other types of fishing gear are also kept for bait in the same manner. In addition iwashi taken in purse seines, lift nets, and stick-held dip nets are also held for bait.

(2) How the fish are kept in the live-pounds

It is essential from the start to accustom skipjack bait to swimming in a confined space. In other words, it is necessary to take fish which have been swimming about in a broad expanse of water and, for convenience in handling, concentrate them densely in a cramped space. If the space in which the fish can swim is suddenly cut down, many of them will die so it is important to set up live-pounds of various sizes and gradually accustom the bait to smaller and smaller ones. Iwashi at the time of capture are referred to as "wild bait [araesa]" or "wild iwashi [araiwashi]". After they have become accustomed to captivity they are called "tame iwashi [iketsuke iwashi]". For keeping a dense school of fish in a small space the live-pound should be set up where there is quite a bit of current, and in order not to lower the vitality of the bait a quiet spot sheltered from the waves and not subject to fluctuations of temperature and water composition should be selected. It is also necessary to provide suitable shade and to guard against attacks by predatory birds and fish. When the bait is to be held for a long time, suitable food must be provided to keep up their vitality, and dead fish must be removed in order to avoid the bad effects of decomposition.

(3) Supplying the bait to the fishing boats

The "tame iwashi" are usually supplied to the fishing boats after they have been kept in the live-pounds for a week or longer and are thoroughly accustomed to living in a confined space. They are handled with care, and the operation is carried out in the form of a commercial transaction, for example, when a bucket holding 8 sho [3.18 gallons] is dipped from the live-pound, a bargain is made for so many yen per bucket. Lately, because of the general shortage of bait, the skipjack fisherman have been making every effort to assure themselves a supply, and there are some who make contracts beforehand with the bait suppliers while others have hired persons who do nothing else but buy bait for them. At times they may even be forced to load "wild bait" in the boats.

(4) Bait in the fishing boat's bait wells

Skipjack boats are equipped with live bait wells in which are kept the iwashi from the live-pounds. The capacity of the live wells depends on the rate at which the water in the boat can be exchanged and also on the species, size, and condition of the bait and the degree to which they have become accustomed to cramped quarters.

(a) Deaths of bait fish due to insufficient oxygen in the water are more frequent with larger fish than with small ones.

(b) Deaths resulting from injury in handling and from stimulation and excitement by conditions in the bait wells are more frequent with small fish than with large ones.

(c) As between the maiwashi [Sardinia melanosticta] and the katakuchi iwashi [Engraulis japonicus], the former is more resistant to injury and excitement, while the latter is comparatively resistant to oxygen deficiency.

(d) The water temperature has an effect on the viability of the fish. If the temperature rises, injured or weakened fish will die all the faster. If the temperature falls, even fish which are in a dying condition will have their lives prolonged somewhat. Consequently, the number of deaths in the bait wells increases and decreases as the water temperature rises and falls.

(e) Resistance to death from lack of oxygen is greater in the anchovy than in the sardine, and greater in small sardines than in large ones. When the fish in the live-well mill around excitedly, it is because the oxygen concentration is insufficient, being below 1 cc per liter, and the water must be changed. It is said that the maximum concentration of fish in a live-well which is advisable is about 8 gallons of sardines per cubic meter.

(f) There appears to be a tendency for more bait to die of injury, excitement, and so forth when the fish are noticeably lean than when they are fat.

In selecting bait fish the first consideration is to choose those which the skipjack like to eat, and the second thing to consider is the ease with

which they can be kept alive. From both points of view we may conclude that the best skipjack bait fish are fat sardine from 2.4 to 3.6 inches in length.

Paragraph 3 Skipjack Fishing Boats

It is not too much to say that the factor which decides the success or failure of skipjack fishing is the efficiency of the fishing boat. The capabilities of the boat effect the length of the fishing season, the range of the fishing grounds, the number of days of operation, the number of fishermen employed, and the ability to hold the catch. In short, the type of boat used affects the whole operation.

As set forth in the first part of this paper, the history of the development of the skipjack fishery has followed the same path as the history of the development of skipjack boats. In the period when Japanese-style boats powered only by oars were in use, the fishing grounds, season, and catch corresponded to the potentialities of these vessels. The years in which Western-style Yaketama [hot-bulb] boats were used saw a corresponding development of the fishery, and at present when steel-hulled Diesel-powered boats of over 100 tons displacement are used, the fishery has reached a stage at which fishing can be carried on at any time throughout the year and in far distant waters, and fishing techniques can be fully exploited.

Fishing boats can be generally differentiated as wooden vessels or steel vessels. There are almost no boats which engage solely in skipjack fishing, the boats generally being called skipjack-tuna boats. They carry on both skipjack and tuna [longline] fishing and are equipped for both types of operation. The design and layout of such a vessel is shown in Figure 13.

The practical requirements of a skipjack boat are

(a) A strong hull, seaworthiness, and ease of operation.
(b) Ability to stay at sea for at least two weeks, and a speed of at least 8 knots.
(c) Well-appointed bait tanks with a large bait-holding capacity.
(d) Good ice storage and capacity to hold a large quantity of fresh fish.
(e) Room for a large number of workers.
(f) Good communications equipment.

These points will be further discussed below.

1, Hull

Present-day skipjack boats are either of wood or steel construction. Wooden boats are from 60 to 135 tons; the majority of them are below 100 tons, and the bulk of them are in the 80 to 90 ton class. Steel vessels are from 100 to 300 tons, the majority being between 120 and 180 tons. The tendency is for larger and larger boats to be used. The reasons for this

are (a) safety at sea, (b) greater cruising range, (c) capacity to hold the necessary quantity of bait, (d) bigger fish holds, (e) increase in the number of fishermen employed, and (f) increased efficiency of operation. In addition to this tendency toward larger vessels, there are signs of a standardization of design in all parts of the country, and steel vessels are replacing wooden ones. The increase in size is naturally limited by the peculiar nature of the skipjack fishery, and with the present character of the operations and the facilities available at fishing ports steel vessels of about 150 tons are the most practical type.

2, Cruising range and speed

Since the recent tendency is for skipjack boats to engage also in longline fishing, the boats operate the year round, fishing grounds are gradually being extended farther out to sea, and operations have become more aggressive. As a result a need has arisen for the greatest possible cruising range, and along with this attention must be given to speed, horsepower, and type of engine.

(1) Types of engines

The two types under consideration are the Yaketama engine and the Diesel engine. An investigation of vessels already in operation shows that from the point of view of fuel oil consumption a 140 HP Yaketama engine uses 0.8 ton per day while a Diesel engine of 160 HP uses 0.7 ton. Thus for its horsepower the Diesel uses less fuel than the Yaketama. Lubricating oil consumption varies with the make of engine, but the Diesel surpasses the Yaketama on this score by about one-fourth. This difference in oil consumption is an important point for skipjack boats, which are coming to be used the year round. The Diesel engine is far superior as far as fuel consumption is concerned.

The Yaketama engine is somewhat superior to the Diesel in power output in relation to horsepower, but not enough so to offset the greater fuel consumption. Diesel engines are most suitable for skipjack boats and most of them are in fact adopting such engines. However, Diesel engines are used chiefly where more than 100 HP are required. The airless injection type of around 200 HP, using 180 grams of fuel per horsepower per hour and 2 grams of lubricating oil, is very dependable and durable, and is the most suitable and most economical type of engine for these boats, which fish in distant waters and as a rule operate for long periods of time alone.

(2) Horsepower and speed

In recent times the need for speed has been discussed from various points of view, but in the case of skipjack boats speed is necessary in order to (a) shorten the dead time spent in going to and from the fishing grounds, (b) increase the number of cruises which can be made during the fishing season, and (c) to give the boat an advantage over other boats operating on the fishing grounds. The speed is related to the design of the hull and the quality and power of the engine. Skipjack boats which

have adopted Diesel engines are powered so that those under 50 tons have about 2.5 HP per ton, those of around 100 tons have 2 HP per ton, and those in the 180 ton class have about 1.8 HP per ton. The object is to maintain speeds of around 10 knots.

3, The problem of bait tanks

Bait tanks are the most characteristic feature of skipjack boats. Their capacity is related to the number of operations which the boat can carry out on the fishing grounds, and by extension to the amount of the catch. It sometimes happens that boats encounter large schools of skipjack which they have gone to much trouble to find, and then are unable to operate because they are out of bait. Indeed, bait is life and death to the skipjack fishery.

(1) The bait tanks are supposed to hold the bait fish in a healthy condition without lowering their vitality or causing them to die until the time when they are to be used on the fishing grounds. In order to accomplish this the following requirements must be met.

(a) The bait fish must be kept as quiet as possible to prevent any needless waste of their energy. For this reason the tanks are located amidships on the center line of the boat where motion is at a minimum and where they are convenient for use. (See Figure 13)

(b) In order to maintain the vitality of the bait fish there must be a thorough circulation of water. This factor has a bearing on the amount of bait which can be kept within a given space. Water exchange is either natural or powered, and in some cases both systems are used. In the natural water exchange system openings are provided in the hull within the bait tanks so that the water will circulate naturally. With a powered system a water pump is installed in the engine-room to provide a constant circulation of water. Ordinarily the pump keeps the tank constantly filled and makes the water circulate within the tank; the overflow runs off from the hatch-coaming on deck through a pipe which leads to the side of the boat. This method provides approximately 30% more water than the natural system and as a result the amount of bait which can be held is greatly increased. A completely water-tight electric light provides illumination within the bait tank. This greatly increases the viability of the bait and lowers the death rate.

(2) Increasing the holding capacity of the bait tanks

By increasing the capacity of the bait tanks it is possible to lengthen the operating time on the fishing grounds and increase the catch. This increased capacity can be attained by installing more tanks, building larger tanks, and by using a powered system to exchange the water in the tanks. However, the balance of the vessel as a whole must be considered in adopting these measures.

4, Stowage of the catch and ice capacity

The ideal fishing boat is one which can bring to market the greatest possible quantity of fish in the best condition of freshness. If we look at the actual capacity of boats of various sizes,

Size of Vessel	Fish Stowage Capacity
30 - 50 tons	3,500 - 7,000 kan [28,945 - 57,890 lbs.]
50 - 70 tons	7,000 - 8,500 kan [57,890 - 70,295 lbs.]
70 - 100 tons	8,500 - 11,000 kan [70,295 - 90,970 lbs.]
100 - 150 tons	11,000 - 16,000 kan [90,970 - 132,320 lbs.]
150 - 180 tons	16,000 - 20,000 kan [132,320 - 165,400 lbs.]

The above figures represent the standard quantities which can be stowed when the catch is properly refrigerated with ice to keep it fresh. The amount of ice used varies with the season and the length of the trip, but in general it is 25% to 35% of the weight of the fish to be refrigerated. When fish are kept iced for use as fresh fish, each 100 kan [827 lbs.] of fresh fish requires about 40 cubic feet of space. The amount of ice carried by fishing boats is as follows:

Size of Vessel	Average Weight of Ice
70 - 100 tons	32 tons
100 - 150 tons	53.7 tons
over 150 tons	54 tons

These figures will vary depending on the efficiency of the insulation in the fish holds. Larger vessels are installing refrigerating machinery. Temperatures in the fish holds should be from 25° to 35° F.

5, Personnel carrying capacity

Since skipjack fishing is based on individual skill, it is necessary to carry as many fishermen of the highest degree of skill as possible. This will naturally be governed by the living space and accommodations in the boat and by the available working facilities. By working facilities are meant the bowsprit and fishing platforms, for the construction of which there are various designs.

The bowsprit is of steel girder type, combined with galvanized gas-pipe. It is broader at its outboard end and the inboard end is attached to the fishing platforms. It is designed to permit more men to engage in the fishing than was possible in the past, and is so constructed that the fish taken will slide along it into the boat.

The fishing platforms are installed along both sides of the boat from bow to stern, and forward of the gangway in the middle of the boat the bulwarks are extended to their outer edges, and the footboards on their upper surfaces are covered with water-tight planking; aft of the gangway the footboards are made of galvanized gas-pipe. The whole construction is strong enough to withstand the pounding of the waves.

The capacity of the fishing platforms and bowsprit installed on a skipjack boat determines the number of fishermen.

6, Water spray installations

This is a special type of installation which utilizes the habits of the skipjack to the advantage of the fishery. A galvanized iron spray pipe about 75 millimeters in diameter is attached from the end of the bowsprit along the edges of the fishing platforms to the stern. A suitable number of spray nozzles are provided and a pump in the engine-room supplies water for the spray. The power of the pump is determined by the amount of water required and the distance to which it is desired to spray it.

7. Communications equipment

This is essential for the safety of the vessel as well as to keep a firm grasp on the fishing situation and to operate the boat economically.

According to figures published in October 1947 by the Survey Department of the Fisheries Bureau, Ministry of Agriculture and Forestry, there were as of June 1947 1,420 skipjack and tuna boats registered with a total displacement of 60,479 tons, giving an average per boat of 42 tons.

Table 3 Skipjack and Tuna Boats (70 tons and over) and Organizations Operation Them (October 1947)

Organization	Number of Vessels	Organization	Number of Vessels
Ichimaru Fisheries Co.	1	Tōhoku Promotions	7
Inui Steamship	1	Tokushima Fishing	1
Uwashima Transport	1	Nakagawa Navigation	7
Kawanami Industries	3	Nankai Company	2
Kantō Fisheries	2	Nishi Nippon Fisheries	2
Katō Fisheries	1	Nichibei Fisheries	1
Kyokuyō Whaling	1	Nichiro Fishing	14
Kyōdō Fisheries	4	Hama Katsuura Cooperative	2
Kiyotoshi Fishing	3	Higashi Nippon Fishing	1
Goyō Fisheries	12	Fuyō Fisheries	2
Kōsei Fisheries	2	Fuji Fisheries	5
Sankai Fisheries	2	Hōkoku Fisheries	10
Sankō Steamship	3	Hōkō Fisheries	11
Shōwa Fishing	25	Hōyō Fisheries	1
Shima Fisheries	2	Marukō Fisheries	1
Jōyō Fishing	1	Marudai Fisheries	1
Takaoka Fisheries	2	Marushin Navigation	1
Daito Fishing	1	Miyako Fishing Co.	1
Taiyō Fisheries	2	Minami Nippon Fishing	4
Taiyō Fishing	13	Mochimune Fishing	1
Taikō Steamship	3	Yamatò Fishing	1
Tagomura Fisheries	1	Wakadori Products	1
Takuyō Fisheries	3		
Tōkai Fisheries	1		

Since the end of the war the skipjack and tuna fisheries, following the trend of the times, have started to work anew. Table 3 shows the vessels in operation and the organizations operating them in the autumn of 1947. Almost all of these organizations started out fresh after the war with newly constructed boats which in their characteristics and size are excellent for skipjack and tuna fishing. However, in view of the present shortages of materials there are naturally defects of quality. As this survey was a general one, there were some omissions, and some changes have taken place since it was made.

Section 2 Fishing Methods

Paragraph 1 Bases for the Fishery

When the fishery is, as it is at present, composed of various specialized elements operating together, the choice of a fishing base and the facilities, size, and ease of supply at that base have a pronounced effect on the operation of the fishery.

The following points should be considered in selecting the base for fishing operations.

(1) Having good fishing grounds within a short distance

This shortens the dead time required for going to and from the fishing grounds, lengthens the operating time on the grounds, increases the number of fishing trips which can be made during a limited fishing season, and brings about increased catches.

(2) Ease of obtaining bait

This means a place very close to the baiting grounds, where it is possible to secure at all times the bait which is essential to this fishery.

(3) Ease of obtaining ice for preserving the catch

The fishing season comes during the season of high temperatures, and because of the way in which the boats are equipped, ice is absolutely essential for holding the catch. Difficulty in obtaining it affects the operating time of the boats and the number of hours they can fish during the season.

(4) Adequate port facilities

In order to enable the fishermen to rest after they have been at sea for from two to three weeks, fighting to get a full load of skipjack while the boat is rocking violently, it is essential that the port be fully equipped with breakwaters, cargo handling facilities, fueling, and watering installations. Such facilities make it possible to shorten the length of time in port and increase the time spent in fishing. It is to find out what sort of luck each boat is having and to coordinate future operations.

necessary that communications facilities be adequately provided in order to be able to find out what sort of luck each boat is having and to coordinate future operations.

(5) Good land and sea transportation

Skipjack fishing bases are selected on the basis of the above requirements.

The bases being used at present are in general as follows. The asterisk denotes bases which are nationally famous.

(a) Boats operating in the Satsunan area
Kagoshima Prefecture - *Yamagawa, *Makurazaki
Kumamoto Prefecture - Ushibuka
Miyazaki Prefecture - Aburatsu

(b) Boats operating in the Kinan area
Kōchi Prefecture - *Shimizu, *Susaki, Muroto
Tokushima Prefecture - several ports
Wakayama Prefecture - *Katsuura, Tanabe, Kushimoto
Mie Prefecture - Owase, Hikimoto, Hamashima, Nakiri

(c) Boats operating in the Zunan area
Shizuoka Prefecture - *Yaizu, Shimizu
Kanagawa Prefecture - *Misaki, Kurihama
Chiba Prefecture - Tateyama, Katsuura

(d) Boats operating in the Sanriku area
Ibaragi Prefecture - Naka, Kuji
Fukushima Prefecture - Onahama
Miyagi Prefecture - *Ishimaki, *Onagawa, *Kesennuma
Iwate Prefecture - Ofunato, Miyako
Aomori Prefecture - Hachinoe

This is the situation at present, but with the increasing size of the boats and changes in the conditions of the fishery the bases are always shifting.

Paragraph 2 Fishing Grounds and Fishing Seasons

The subject of fishing grounds and seasons has been pretty well exhausted in the section dealing with the distribution of the skipjack, but it should be noted in addition that they are not the same from year to year because of variations in the movements of the schools and in the oceanographic conditions. Despite these considerable variations, however, a study of skipjack catches of the past, with a consideration of various other circumstances, can lead to some general conclusions.

1, Satsunan area

This area has its center from Takeshima to the Tokara Is. and extends past Amami Oshima and the Ryukyus to the east coast of Taiwan, covering a

distance of 500 miles north and south. The important fishing grounds within the area lie from off the Satsunan Shichitō south to the waters northeast of Miyakojima.

The season begins in February around the Amami Is. and the Iheya Is. Fishing begins around the Tokara Is. in March, and in April catches are made all over the area. In June and July the season is at its height in Okinawa and Taiwan waters. In May and in the fall season from August to October the Tokara Is. area is regarded as an especially excellent fishing ground. At the end of the season in November and December the schools move back and the season ends where it began around the Amami and Iheya Is.

Fishing grounds in the Satsunan area are limited to reef areas, and the grounds are developed around the reefs. Fishing is done within the 100-fathom line and around the many sunken reefs from the Satsunan Shichitō to the Tokara, Amami, and Okinawa Islands. Especially notable fish reefs are Gonsone, Gaja I., Nishisone, Gajatako, Gogōsone, Hachigōsone, Ogansone, Oganmitsu, and Yokoate Nishisone, all of which lie in the western part of the area enclosed by a line drawn from Gaja I. in the northern part of the Tokara Is. to Yokoate I. in the south, and, in the Amami Is., Torishimasone, Gyoseisone, Seigyosone, Nishisone, and others, all of them around Torishima in the western part of Tokunoshima. There are many other fish reefs in addition to these. Changes in oceanographic conditions bring about remarkable fluctuations in the catches made on these reefs, and there is a certain amount of variation from year to year. The boats move from reef to reef depending on the fishing situation. The reefs all have depths of 30 to 100 fathoms.

The fishing seasons and fishing grounds in this area are roughly as follows. In the spring season from February to May fishing is centered on the Satsunan Shichitō and is carried on at the fish reefs of the Tanegashima and Yakushima areas. In the summer season from June to August the fishing grounds develop in the waters east of Taiwan. In the fall season fishing is carried on in the grounds near the Yaeyama Is. In the past some boats used to go down to the Borneo and Celebes area during the winter season.

The most profitable fishing in this area is that for sedentary schools in the spring season and on the Yaeyama Is. grounds in the fall.

2, Kinan area

The season in this area is generally from March to August, and the grounds are comparatively close to the coast. They vary from year to year as the currents shift, but in the Tosa area they are 20 to 30 miles south of Tosa, that is, in the waters north of the main stream of the Kuroshio. Fishing is carried on here by small vessels beginning in the middle of April.

(a) In the waters 50 - 240 miles southwest and south-southeast of Ashizuri Misaki, the first fish are usually seen between the middle of February and March. The season opens when the water temperature is around 19 - 20° C.

(b) Around the sunken reefs in the vicinity of Okinoshima big catches are made from April to June in years when the current through the Osumi Strait strikes in strongly to the coast at Ashizuri Misaki and the water temperature is about 20°C.

(c) In years when the Kuroshio comes in weakly toward Muroto Saki, catches are made only around April when the water temperature is about 20°C. and only in the waters 30 - 40 miles off Muroto Saki, that is, in the vicinity of Taishō-bai.

(d) Schools come into Tosa Wan and are caught there in July and August. The water temperature gets up to around 25°C.

(e) Off Kumano Nada the season for spring skipjack opens in March, is at its peak from April to May, and ends in June. In summer and autumn the schools are greatly decreased in number, but catches continue to be made. The schools in this area come in close to the coast and are fished in waters 20 to 30 miles off shore from Shiomisaki to Owase when the water temperature is about 19°C. In the peak season catches are made from 50 miles south to 100 miles southeast of Shiomisaki and activity increases as the fish gradually come closer in to the coast of Kumano Nada. In the latter part of May the schools diminish and fishing ends in June. The average water temperature is about 19 - 22°C.

3, Zunan area

Fishing in this area centers around the Izu Shichitō, the waters around Hachijōjima and Ogasawara being especially famous. The fishing season begins in the Ogasawara area in February, and at Hachijōjima and Aogashima in March, the peak of the season being from April to June. By April the fishing grounds extend to the waters off Bōshū, and they gradually shift to the Sanriku area. Fishing grounds are found at the many reefs within a line drawn from Aogashima south of Hachijōjima through Nishinoshima west of Ogasawara to Kita Iwōjima.

Among these fish reefs the most notable ones are Higashiba, Satomae, and Nishiba, all on the north side of Torishima, and the waters around Sōfu Iwa, as well as Kaikataze, Kaitokuze, and Zenisu on the south side of Nishinoshima, These are all within the 30 to 100 fathom lines. In this area a distinction is drawn between sedentary skipjack and migratory fish.

The season generally begins in March or April, is at its height in June and July, and ends around October.

Around May in the Sōfu Iwa, Aogashima, and Sumisu Shima areas the water temperature is 20° to 22°C. In the middle of the month the fishing grounds shift to the westward. The peak season of the early part of May is centered 60 miles east of Hachijōjima around 31° N - 139° E, and 32-33° N - 138-140°E. In the latter part of the month the center of the fishing grounds shifts to the east of Izu, particularly to the waters around 33° 20' - 34° 40'N -- 140° - 141° 30' E. Suitable water temperatures for fishing in this area appear to be 19 - 22°C.

4, Northeastern area (Sanriku area)

The schools which appeared in the Zunan area have moved to the waters off Inubō Saki by June. The fishing grounds gradually extend to the waters off Shioya Saki in Iwashiro in June and July, and to the waters off Kinkazan from June to August. From August to October they extend to 500 miles off Kamaishi in Rikuchū with the fishery centered about 350 miles off shore. Some catches are made within 50 to 60 miles of the coast from schools which happen to come in close.

The season starts in the latter part of April around 40°N -- 145°E. The peak season is in July and August around 38°N -- 148°E. Fishing ends in the latter part of October around 40°N -- 145°E. All of the schools in this area are migratory fish and they are divided into what are called ascending and descending skipjack. Within the area they stop for a while at one place and then swim on. The season is long, the grounds are extensive, and the catch is the largest of all the area.

Paragraph 3 Detection of Schools

1, Preparations for fishing

In making preparations for a trip the number of days of cruising is determined beforehand depending upon the fishing ground which has been selected for operation, and a number of extra days of reserve cruising range are added to the calculations.

(a) calculation of fuel requirements, (b) preparation of provisions and drinking water, (c) loading of ice, (d) taking on bait, (e) inspection of the hull and engine, (f) preparation of the fishing gear.

Success in fishing is determined by the completeness of the preparations made. This is true in other fisheries as well, but especially minute care is essential in preparing for a skipjack fishing trip because in this type of fishing so many men have to work in such a small working space. Furthermore the fishing must be done in a short space of time, good opportunities for making a catch are extremely few, and, as the fortunes of the fishery direct, it may be necessary to operate with full efficiency for an extremely short time. Consequently the preparations for a trip must be thorough and minute.

If even one item is omitted from the preparations, it will be impossible to make a good catch. The amount and quality of the bait are particularly vital considerations. Figuring on a scoop holding 1 to [3.97 gallons], a 20-ton boat will prepare 30 scoops of bait, a 50-ton boat 60 scoops, and a 100-ton boat about 100 scoops. The amount of bait which is carried naturally depends on the capacity of the bait tanks, but for present-day skipjack boats a suitable quantity should be a number of scoops within ten per cent of equalling the number of tons of the vessel's displacement. With a bait tank 6' x 6' x 5', the capacity to hold fish of 3.6 - 4.8 inches in length is expected to be 80 scoops of sardines or 60 scoops of round herring. One scoop can dip up 1 to

[3.97 gallons] or 800 -- 1,000 sardines 3.6 to 4.8 inches in length. In actual practice shortages of bait bring about marked deviations from this standard.

The loading of ice for preserving the fish is another point which requires careful attention. When temperatures are high, it is hard to maintain the freshness of the catch and one would like to load as much ice as possible, but on the other hand the result would be to reduce the quantity of fish which could be loaded, which would not be satisfactory. This means that it is necessary to determine just the right amount. Allowance must first be made for loss by melting depending upon the quality of the insulation of the fish hold and the length of the cruise. Ordinarily a 30-ton boat carries 4 to 8 tons of ice, a 50-ton boat 10 to 20 tons, a 70-ton boat 20 to 30 tons, a 100-ton boat 20 to 35 tons, and a boat of around 150 tons carries 40 to 60 tons. Since skipjack boats make relatively short cruises, they tend to skimp on ice. Particularly with the tight ice situation which prevails in the fishing ports at present they are running far below their minimum needs.

2, Choice of a fishing ground

When one is going to engage in skipjack fishing, one first gets a detailed knowledge of the migrations of the schools in ordinary years, and then one obtains data from all areas in order to be able to make an accurate judgement of the situation and set up a sound operating policy. One then proceeds to take the following steps.

(A) Deciding on the area of operation

The area is determined in accordance with the season. Once the area is decided upon, the boat moves to the port most convenient for operations within that area and completes all preparations for its trip. During this time the skipper continues to collect information from all parts of the area. By means of reports from the fishing grounds he arrives at a knowledge of the number of schools and the direction in which they are heading at the time of sailing, calculates the number of days the boat will take to reach the grounds, and decides where within the area he will fish. It is necessary to collate the bulletins of the Fisheries Experiment Stations, the reports of the various fishing boats, one's knowledge of the habitual movements of schools within the area, and the opinions of experienced persons, and then to proceed confidently to the area which one judges to be most favorable.

(B) Precautions to take on the way to the grounds

After sailing for the fishing ground which has been chosen, close radio contact should be kept with cooperating vessels at all times and reports should be received from the base. Attention should be paid to changes and indications of change in the fishing situation, and plans should be modified accordingly. When the boat approaches the scheduled fishing ground, constant attention must be given to the water temperature and color in an effort to find a water mass of a suitable temperature.

At the same time a sharp lookout must be kept for fish and every effort must be made to discover a school at the earliest possible moment.

(C) Finding fish on the grounds

On arrival at the grounds preparations are made to be ready to fish at any time and all hands strive to sight a school.

(1) Investigation of water temperatures

Efforts are made to discover water temperatures which are known to be suitable at the season and in the area in order to determine the limited extent of the fishing grounds within the broad expanse of the ocean.

(2) When the grounds being explored have been narrowed down, a feather lure is trolled to ascertain the presence of a school.

(3) Attention is paid to the movements of sea birds on the grounds. When a flock is sighted, they are approached and the surface of the sea is scanned for activity. This is because skipjack schools at the surface are generally accompanied by flocks of birds. When a flock of birds flies wildly up and down and to the left and right at the surface of the ocean it means that there is a school of skipjack swimming at the surface. When a flock of birds flies high and slowly it often indicates that there is a school of skipjack below the surface. When the birds sit quietly on the surface it can be judged that the school is swimming rather deep. The birds are an important aid to the discovery of such skipjack schools, which the fishermen call bird-associated schools [torizuki namura].

(4) Schools associated with various things

(a) With whales -- Schools which accompany and live in association with sardine whales. First sighting the great body of the whale, the boat gradually approaches to ascertain whether or not there is an accompanying school of skipjack. This is a method of taking advantage of the habits of the schools.

(b) With sharks -- Skipjack schools also accompany basking sharks. By sighting the shark the school is discovered, and this too is a method of taking advantage of the habits of the fish.

(c) With floating logs -- Utilizing the skipjack's habit of swimming along with a piece of wood floating in the ocean, one first detects the presence of driftwood and then ascertains whether or not it is accompanied by a school.

(d) With sardines -- This method takes advantage of the skipjack's habit of surrounding and concentrating a school of sardines. A watch is kept for the peculiar appearance of the surface of the ocean where a school of skipjack is feeding on a school of sardines.

(e) Unassociated school [sunamura]-- This type of school is discovered by sighting the particular signs caused by the presence of the school itself.

(5) Times when schools can be spotted with the greatest certainty

With the fishing methods in use today it is impossible to fish after the sun goes down. The time in which it is possible to fish is limited to the hours from dawn to dusk. There has not yet been any concrete investigation of the movements of skipjack schools during the night and so no conclusions can be reached on that subject. It is a peculiarity of the skipjack that the schools become most active, and therefore most easily discoverable, at dawn and at dusk (asamazume, yumazume). Around sunrise in particular is the best time. Since in general more fish are taken during the forenoon, the particularly experienced old-timers should be put on watch then. There are quite a few of these old-timers who have an astonishing skill in finding schools by the smell of the water and other special signs. That is where the factor of individual skill comes into play in this fishery.

More catches are made in cloudy than in clear weather, and when the weather shows signs of changing, the chances of spotting schools are good.

(6) Clues to the discovery of schools which bite well

Good-biting schools can be found more easily when the water is particularly clear and when the current is swift rather than slack. The current in the open sea should be 5 - 6 knots and 7 - 8 knots near an island. The effect of the stage of the tide is felt only near islands. Fish living on reefs come to the surface according to the strength of the current. In general the fish bite best at and before and after high and low water. The calmer the sea the more the fish come to the surface and the more opportunities there are for sighting them. The time after a period of low atmospheric pressure is also good.

(7) Water temperatures and methods of discovering schools

If the water temperature is not suitable, the schools will not surface even though they may be present, and it is difficult to discover them. Each region has its standard average water temperature for each season; when higher than average temperatures are encountered, even though they may be above the range considered favorable for fishing, the boat will change its course and seek suitable temperatures. In areas where water masses are mingled, with sharp variations in water temperatures clearly indicating a meeting point of currents, many good-biting schools can be sighted even though the temperatures are not in the range usually considered suitable for fishing.

3, The relationship between schools and the way they bite

It is not an uncommon experience to sight a school only to find that the fish cannot be caught because they will not come to the bait, but it is

not yet possible to tell with certainty which schools will take the bait and what sorts of schools will not. On the basis of long years of experience and study some general predictions can be made, but the problem must wait for further investigation. In the first place there is no scientific standard in terms of so many fish caught per minute to determine what is to be considered a good-biting school and what is not. Mr. Suehiro of the Fisheries Experiment Station has indicated the following standard for determining whether a school takes the bait well or badly.

How well the fish bite is shown in terms of fish taken per man in 100 minutes, a figure which is represented by Q. The number of fish caught is b, and the elapsed time in minutes is t, while the number of hooks fished is f. The formula is

$$Q = \frac{b}{tf}$$

$Q \leqq 16$ means poor biting
$Q \geqq 17$ means good biting

This means that if one man in 100 minutes hooks 16 or fewer fish, the school is not biting well, and if he hooks 17 or more it is a good-biting school.

If we apply this formula to the actual operations of skipjack boats, we get the following conclusions. Skipjack schools in the open ocean generally bite well, and island skipjack generally bite badly. When schools which bite poorly turn up in the open sea it is usually in comparatively deep water. The reason for this is explained as being related to the supply of natural food.

(The relationship between season, weather, and time and the way the fish bite)

In the beginning of the skipjack season the fishing grounds are for the most part around islands and reefs. Consequently the fish do not generally bite well because of the abundance of natural food. Toward the end of the season in the autumn the schools are migrating in the open sea and the fish bite well because they lack natural food.

Table 4 Relation of Weather to Biting

		Clear	Cloudy	Rain	Fog
bit well	number of schools	86	105	12	4
	per cent	74	84	75	100
bit poorly	number of schools	30	20	4	0
	per cent	26	16	25	0

Table 5 Relation of Fishing Time to Biting

		4:00-8:00 a.m.	8:00 a.m.-4:00 p.m.	4:00-10:00 p.m.
bit well	number of schools	51	105	41
	per cent	93	77) = 90%	79
bit poorly	number of schools	4	31)	11
	per cent	7	13	21

According to Table 4, which is based on actual operations, the fish bite better in cloudy weather than in clear weather. The data for rain and fog conditions are too scanty to be relied on, but they do not necessarily indicate worse conditions than prevail in clear weather. It appears that wind force has no bearing on how the fish bite.

Table 5 shows the results of actual observations of the relationship between the time of day and the way the fish take the bait.

Paragraph 4 Catching the Fish

1, Operation of the Fishing Boat

(1) Measures taken with regard to the school

The Fisheries Experiment Station has consulted fishermen in all areas on the question of how the boat should be maneuvered with respect to the school in order not to lower the rate at which the fish bite and in order to get the best possible catch. Their answers indicate that operations should be conducted as follows:

(a) The boat should cut around the head of the school and throw bait. (Fukushima Prefecture, Ibaragi Prefecture, Mie Prefecture, Miyazaki Prefecture, Kagoshima Prefecture).

(b) The boat should move to the rear of the school and throw bait. (Iwate Prefecture).

(c) The boat should approach so that the school is up wind. (Mie Prefecture).

(d) The boat should approach so that the school is between the boat and the sun. (Mie Prefecture, Kagoshima Prefecture).

With regard to sedentary schools which live on a reef,

(a) It makes no great difference how the boat approaches. (Kumamoto Prefecture)

(b) The boat should approach the densest part of the school. (Miyazaki Prefecture)

These are the ways the boats are maneuvered in the various areas, but since (a) and (b) are contradictory no definite conclusion can be drawn. These are customs of many years' standing, or else they are based on the individual ideas of the fishing captains, however, with the development of fishing boats and especially their increased speed it is probably necessary for each individual to decide on the approach to be adopted in a given situation without being needlessly bound by old customs.

(2) Measures taken with regard to the method of fishing

Since ancient times there has been a regional distinction between the two methods of fishing from the port or starboard side of the boat. If we consider the present patterns of operations in various localities,

(a) In the Kagoshima area once the school is sighted the boat heads in the same direction as the school, bait is thrown to bring the school to the port side, and the boat is allowed to drift with the wind on the starboard beam. Fishing in this way with the wind at one's back is supposed to make the fishing lines carry out to their fullest extent and extend the radius of operation by that much, and also to speed up the fishing by preventing lines from getting tangled together. This method of fishing from the port side is widely practised in western Japan.

(b) In the Shizuoka area when the school comes up to the bait, the boat is stopped with its starboard side downwind and the fishing is done from the starboard side.

(c) In cases where the school is dense and the fish are biting extremely well so that there is no danger of losing them no matter how operations are conducted, after the approach is made by method (a) or (b), if the situation permits, fishing may be done from both sides of the vessel.

It is wrong to set up restrictions on operations such as is done by methods (a) and (b). Fishermen should be trained to respond immediately to the school and should be able to begin fishing quickly on either side of the boat. The methods of fishing only from the port or the starboard side are bad doctrine.

With modern skipjack boats having fishing platforms from bow to stern and the greatest possible number of fishermen, we should bring the schools up to the bait skilfully so as to be able to fish from both sides of the boat.

2, Operation of the fishing gear

When the boat has approached the school and is in a position to fish the following procedures are generally employed.

(1) Disposition of personnel

In order to begin fishing the following assignment of tasks is made.

(1) Fishermen [tsurikata] -- The largest number of men are assigned to hooking fish. They are stationed along the fishing platform according to their skill, the old-timers being given the positions at the bow and stern. The most skilfull and strongest young men are stationed at the center of the platform. This arrangement prevents the school which is coming in to the bait from being frightened away, and raises the efficiency of the fishing operation. The other fishermen are stationed between these two groups. With the whole vessel ready and in the peak of condition, the disposition of personnel is carefully determined as a prerequisite for making the largest possible catch.

(2) Chummers -- These are the most experienced men in the crew, and they are stationed at the bow and stern and at other strategic points. Experience is needed to be able to observe the density of the school and the way the fish bite and to know how to throw bait so as to bring the school in to the side of the boat and hold it there for a long time. When fishing begins, the bait is thrown 50 or 60 fish at a time from both the bow and the stern on a large boat or from amidships on a small boat. Thereafter bait is thrown continuously in quantities of 5 to 10 fish at a time.

(3) Bait boys -- Inexperienced youngsters handle the job of supplying bait to each fisherman's bait bucket. The number so employed depends on the number of men fishing.

(2) Hooking skipjack

(1) Bait fishing

(a) Baiting the hook

There are various methods of baiting the hook, all of them designed to lower the vitality of the bait fish as little as possible. It is necessary that the method used be quick and convenient. When the school is biting well, the hook may be stuck through the back, neck, snout, eye, or from the lower to the upper jaw of the bait fish, all of which methods prevent the bait from swimming freely, and in rare cases a bait fish may even be cut in two and each half used separately, but ordinarily the hook is stuck under the clavicle [coracoid ?] of the bait fish.

(b) Hooking the fish

Each of the fishermen handles one pole. When the boat has approached the school and bait has been thrown, the way the fish take to the bait is observed; if they take it well, the boat is completely stopped, and the spray pump is set to spraying out sea water in order to increase the effect of the bait. At the same time the hooked bait is dropped into the water and allowed to swim as the pole is manipulated. The pole is handled in either a standing or a sitting position. The latter method is customarily used in the Kagoshima area, but it detracts from the agility of the fisherman's movements, although it does give stability to his body. This position is suitable for use when the boat is rolling violently, but in general fishing is done from a standing position.

The butt of the fishing pole is planted firmly against the right thigh and the grip is held in the right hand. The fisherman manipulates the pole so as to make the bait swim in the water, and waits for the skipjack to strike. When a fish bites, before it can change direction the tip of the pole is immediately bent into the form of the character ku 〈 an obtuse angle 〉, and the fish is lifted up in such a way that no slack develops in the line. The skipjack is caught under the left arm and the hook is removed from its mouth.

There are two methods of handling the fish when they are swung in toward the boat. One is to catch the fish under the left arm, and the other is to swing the fish up out of the water in an arc so that the hook will naturally free itself when the fish is somewhere over the fisherman's head and the fish will fall into the boat.

(2) Fishing with artificial lures

When the skipjack are biting well, the fishermen working from the amidships portion of the fishing platform to the stern will use artificial lures suited to the size of the fish and the fishing conditions. The use of such lures saves bait, saves the time required for baiting the hook, and increases the efficiency of the operation. The throwing of appropriate quantities of bait is continued all the while so that the school will not disperse. When all of the fish in the school have been taken or the fish have lost their taste for the bait and have run away, fishing stops and the search for another school is begun.

Fishing continues from 10 minutes to one or two hours, and sometimes on rare occasions it lasts all day. It is necessary that the crew be ready at all times to work as a team.

It sometimes happens that from 4,000 to 5,000 fish are taken from one school in the space of about 30 minutes, while at other times more than an hour may be spent in catching four or five hundred fish. With good luck a boat may [illegible] on a full load of fish in one day, while other boats may fish for [illegible] days without filling the boat. In addition to the boat, the personnel, and the skill with which fishing is done, the factor of luck also plays a part in determining the differences between the catches made by various boats.

(3) Measures taken after the fish are caught

When the fishing of one school is finished, the catch is packed into the fish holds with crushed ice. If fishing continues for a long time, the fish are iced down whenever an opportunity offers. Every effort is made to stow the catch as quickly as possible and to avoid leaving the fish for very long on the deck in the heat. Once the bait is used up the bait tanks are also used as fish holds to increase the amount of fish stowage.

(4) Notes on fishing gear

(a) Poles -- Ordinary fishing poles can be used on the average for about five months, and short poles become useless in one month. Usually three or four poles are kept ready for each fisherman, and the vessel always carries twice as many poles as there are fishermen aboard.

(b) Hooks -- Each fisherman always has ready large and small hooks, five or six of each, with the leaders attached, along with a considerable length of fishing line. A vessel going out on a trip will have ready poles for use with artificial lures (where poles used for such fishing differ from those used with bait) to the number of about two-thirds of the number of crew members, with two or three hooks for each.

(c) Trolling hooks (searching hooks [saguri hari]) -- Each boat will have prepared two sets of gear and five or six hooks.

(d) Bait buckets -- One for each fisherman with some extra ones.

(e) Dip nets -- Nets of various sizes are prepared for dipping bait from the tanks, for placing it in the ready-box, and for distributing it to the bait buckets.

@ In what respects do skipjack fishing poles differ from ordinary fishing poles?
@ What precautions are necessary for keeping bait fish strong?
@ What different kinds of bait fish are used for skipjack fishing? What are the differences between them?
@ Investigate the construction of bait tanks. Note their location and size, calculate their capacity, and ask the captains how much bait they will hold.
@ When skipjack boats are leaving their base for a trip, how do they get the necessary information on the fishing situation?
@ On what sort of data do they base their decision as to which grounds to fish?
@ How do they find the schools on the fishing grounds? Ask the captains about their experiences.
@ Why is water sprayed on the surface of the sea when fishing for skipjack? How do the individual fishermen work when hooking fish?

Chapter IV

An Examination of Skipjack Fishing Methods

Section 1 A Critique of Pole Fishing for Skipjack

Paragraph 1 Advantages and Disadvantages of Pole Fishing

From ancient times down to the present day the skipjack fishery has changed very little, and the start of the season still sees the same brave bustle of activity at all of the fishing ports. If we consider the fishery from the point of view of methods, we find that down through the ages there have been limited changes in the gear and, of course, in the methods of operating the boats, but in its essentials the fishery is no different from what it was in ancient times. Let us try to analyze this situation a little.

The fishing method in use at present, insofar as it applies to skipjack, represents an extraordinarily wonderful discovery, and admits of no rivalry by other methods.

Contented with the results obtained by the traditional methods and unwilling to run the risk of trying to force a change, we have fallen into complacency and have failed to devote our energies to research. Leaving that out of consideration for the present, let us try to investigate the methods now in use. In the first place, the points of superiority of the pole fishing method are the following:

(1) This method makes the best use of the habits of the skipjack. The schools which migrate into Japanese waters are mainly hunting for food and are in a half-starved condition. The method takes advantage of this fact, and by using bait which suits the taste of the fish they can easily be taken.

(2) The schools which migrate into our waters every year are far greater in numbers than the catch which is made, and it is the perpetual abundance of this stock which makes it possible year after year to take quantities of fish much greater than would be expected from the rule of one fish to one hook which is the basic concept of pole and line fishing.

(3) The fishing grounds are rather far out at sea, and in the past it has been regarded as technically impossible to operate with nets. At the present time, no method has appeared which can rival pole fishing, and the number of vessels suitable for deep sea operations is small. Consequently, the fishery is dominated by a small number of specialized vessels which can operate economically and profitably without forcing themselves to any undue exertions. The natural result has been to follow the path of least resistance, to neglect study and efforts to devise new methods, and to operate on a hand to mouth basis, and this is the condition which has obtained down to the present day. In spite of this, the fishery has, even in the form of its operations, reached a point of superiority high above that of any other fishery.

(4) In comparison with other fisheries, operations by this method do not require great quantities of special materials and equipment, and the ratio of fish caught to materials required is superior to that of any other fishery. Progressive changes through the years have involved only a broadening of the scale of operations, the use of larger vessels, and an increase in the number of fishermen in the crews. The skipjack which are caught are in comparatively high demand, and with the freedom from injury to the fish which is an advantage of pole fishing and the good degree of freshness which is maintained, the fish also meet the demand for dried fish-stick material. The manufacturing of dried skipjack stick has been a positive support to the pole fishery down to the present day.

The points detailed above are thought to be the advantages of the pole fishery for skipjack, however, if we examine these points intrinsically, we find that they are by no means decisive. In short, it is just a case of no fishery having appeared which could rival the skipjack pole fishery. In other words, if a better method were devised, even the skipjack pole fishery would have to give way to it. If we inquire as to what kind of conditions a fishery would have to meet in order to replace the pole fishery, we must conclude that it would, in the first place, have to be free of the defects of the pole fishing method. The points which are regarded as the defects of this method are the following:

(a) Bait is necessary and the handling and transportation of the live bait is extremely inconvenient.

(b) With operations limited as they are at present to the daytime, there is a need for an investigation of factors affecting the hours of operation.

(c) The results are controlled by the way in which the skipjack schools take the bait. At its worst, this factor may lead to the boat's being in the midst of a school without taking a single fish. Up to a certain point, this fishery is extremely aggressive, but it does not, after all, succeed in escaping completely from the category of passive fishing methods. The answer to the question of how to turn this passivity into aggressiveness will probably indicate naturally what is to be the future state and existence of the skipjack pole fishery.

Paragraph 2 Plans for Improving Pole Fishing

(1) A plan for solving the bait problem.

As explained before, one difficulty with the fishery at present is the bait problem. The skipjack season is very short in each locality and during this short season, the boats must work to the fullest extent of their capabilities. The fishermen may be waiting for the season to open and then have to postpone going out to fish because of their inability to get bait, or they may be out at sea enjoying good fishing and then all the boats will have to crowd back into port solely because of insufficient bait. When they try to operate aggressively over a wide expanse of fishing grounds, they may find that sudden changes in the water temperature will kill their bait and force them to stop fishing. There are many ways

in which bait throws obstacles in the way of fishing. The solutions to these difficulties are being studied as pressing problems in all areas, but on a common sense basis the following suggestions are made.

(1) Direct management of bait catching and holding.

At present, the bait supply is uneven because of the shortage of live-pounds. Dishonest suppliers of bait are taking advantage of this situation and the bait supply business often falls into a state of confusion. The following remedies are suggested:

(a) Supplying one's own bait.

This method should be advantageous in large-scale operation where three or more skipjack boats are run on a planned basis. Bait can be taken with small-scale gear, bait fish of the desired size can be selected and kept, the excess can be disposed of elsewhere, and the boats can concentrate on catching skipjack without having to worry about obtaining bait. If lack of capital or other causes make it impossible to establish a private bait supply set-up, a live-pound could be lent to a bait supplier and a contract made for a steady supply of bait.

(b) Dispatch of bait boats to the fishing grounds.

Bait supply boats could be stationed on the grounds where the fishing boats are concentrated to provide a suitable supply of bait for each boat. These vessels could also buy the catches of the fishing boats or else take over the task of transporting the fish back to port in order to save the time required for each fishing boat to go back and forth. This would be one plan to increase the efficiency of operations. This method would enable the fishing boats to seek more distant grounds and remain continuously on a good fishing ground, and would open a new field for the expansion of the industry. In addition to carrying bait, the boats would have to be equipped with fish holds and ice or refrigeration machinery, and they would probably have to be prepared to supply marine supplies, fuel, provisions, and so forth. This is thought to be a problem for the skipjack fishery of the future.

(2) A step further could be taken and the skipjack fishery could be run on a tender and fleet basis.

Section 2 Net Fishing Methods for Skipjack

A thorough consideration of the bait problem leads to the investigation of fishing methods which do not require bait. With such methods the problem of whether or not the fish take the bait well would naturally disappear and the restriction of operations to the daylight hours would be broken through, making it possible to develop night fishing. To fish at any time and in any place, we must consider the use of nets, particularly the purse seine. These have been tried out before, but in every case, failed to produce the expected results. With a thorough cognizance of the conditions, we should make a detailed study of the reasons for failure and then make a fresh start.

Paragraph 1 Attracting Skipjack with Lights

Experiments using fishing lights to catch skipjack have not been thoroughly gone into as yet, but we have occasionally heard of cases where skipjack were attracted to lights which were being used to catch other kinds of fish. There is little data to go on and it would be hard to reach a definite conclusion, but there is a great need for further investigation on this point. The facts which we have are all from cases where fish other than skipjack were the object of the operations and the lights were used in waters far from the skipjack grounds. The strength of the lights, too, was not adjusted with the object of attracting skipjack. In view of this, it is thought that some degree of success could be expected from such a method.

(1) A report of catching skipjack by the use of lights

According to a report by Mr. Umekichi Shiozaki, skipjack were successfully attracted with lights near Uwashima in Ehime Prefecture on August 10, 1934.

(a) Catching skipjack by means of a purse seine

Place . . . Near Okinoshima and Futanarabishima in the waters off Uwashima in Ehime Prefecture.

Time . . . August 10, 1934 (first day of the seventh month of the moon calendar)

Gear . . . Purse seine, 660 yards long, 132 yards deep

Lights . . . Underwater lights, 24 - 32 volts, 170 - 200 watts. Five lights, one per vessel. There were four light-boats and one fishing boat. Their disposition was as shown in Figure 15, with the fishing boat at the center of a square having one of the light-boats at each of the corners. The distance from the fishing boat to the light-boats was 400-500 meters.

Operation - Each boat lowered its light from 1 to 2 meters below the surface and illuminated 6 - 7,000 tsubo [TN. 1 tsubo - 3.31 sq. meters] of the sea surface. The lights were kept on from 4 to 8 hours, and as the fish assembled the fishing boat ordered the light-boats to close in. The light-boats slowly brought their schools of fish in to the center and when all of the fish were assembled in one group, the light-boats turned off their lights. The fishing boat then shot its net and surrounded the fish.

Concentration of fish . . . Since the preceding evening, each light-boat had been using a 32-volt 170-watt light (total 5 lights). In the beginning, the young sardines gathered all around. After a few hours, countless skipjack assembled. About 3:00 A.M. the boats drew in and the net was shot. About 5:00 A.M. when the lifting of the net was begun, there were

estimated to be more than ten thousand skipjack gathered into the bag of the net. (Each fish weighed about 530 momme [4.38 lbs.]). These fish ran about wildly, breaking countless large holes in the net, and by the time the net was hauled in, most of them had escaped. The catch was 4,100 fish weighing 2,173 kan [17,971 lbs.]. The net was designed and operated with the object of catching sardines, and consequently invited results of this sort.

(2) A catch of skipjack in a four-angled lift net [yotsude ami]

This type of net is used in the Uwashima area for taking small mackerel-scad, mackerel, jami, chirimen iriko, and other small fish. It is 100 fathoms long and 25 fathoms wide and is a type of fixed gear which is fastened to the bottom. One would never dream of taking skipjack in it. The net was operated off Asobiko near Uwashima on August 10, 1934, the first day of the month in the lunar calendar, by a fleet consisting of a fishing boat and three light-boats.

The fishing boat used a 24-volt 120-watt underwater light, while the light-boats used 16-volt 100-watt lights. At first enormous quantities of plankton assembled and in two to five minutes, jami gathered and swam around under the lights. Small mackerel-scad and mackerel began to flash their white bellies, flyingfish cut straight across under the light, ribbon-fish like silver snakes slid along the sides of the boats, and sardines, squids, and balloonfish swam about drunkenly. At a depth of ten or more fathoms, what appeared to be bream were seen swimming. After a while, about ten fathoms deeper, large fish in numbers from several hundred to over a thousand were seen to appear suddenly and then disappear. At first they were taken for large mackerel-scad. As it grew later, the jami became densely concentrated around the lights where they swam about causing small waves on the water. About 100 meters away, around the edge of the lighted area, the splash of a leaping fish could be heard from time to time. The large fish which had shown themselves earlier were now swimming slowly close to the light about 10 fathoms down. At 2:00 A.M., the light-boats were ordered to close in and concentrate the fish. The fishermen began to draw up the net slowly and gently. Three hundred skipjack were quite unexpectedly taken that night along with squid, mackerel-scad, mackerel, jami, and so forth. Other boats which fished that same night using carbide lamps did not take any skipjack.

There are two or three other examples of the use of fishing lights, but if we consider them all together, we can arrive at the following two explanations.

(a) Skipjack seem to have a tendency to assemble around a light.
(b) The same result is arrived at by the skipjack's happening to gather around the light in pursuit of the sardines which the light collects. In other words, it is indicated that there may be a direct and an indirect concentration of fish around the light.

These experiments make possible the following conclusions:

(a) It is possible to fish for skipjack at night. In order to do so, lights (underwater lights) should be used.
(b) Skipjack either school at night or may be induced to do so by using a light.
(c) It will probably be convenient to catch skipjack which have been attracted to a fishing light by using a purse seine or a similar type of gear.

Paragraph 2 Purse Seining for Skipjack

Since the end of the war, with the increased propanganda for the extension of the skipjack fishery, the use of purse seines is being seriously studied and attempts are being made to put them into use.

Plans have been made in the past for taking skipjack with purse seines, but they all ended in failure. There were various reasons for this, but in general, they were the following:

(a) Insufficient research on the skipjack schools.
(b) Unsuitable gear and vessels, and a lack of seriousness in carrying out the operation.
(c) The lack of experience on the part of the personnel in handling the gear and the boats made experimentation almost impossible.

A fresh attack on the problem, with the correction of these conditions, is being considered. This will be based on the purse seine fishery for skipjack and tuna which is achieving splendid results on the California coast.

The California purse seine fishery is carried on by the largest and best of the sardine purse seiners and the peak of the season is during the three months of June, July, and August. Since the black tuna purse seine fishery uses the phosphorescence in the water to find the schools, dark nights are chosen for such fishing operations. During the period of bright moonlight, the boats swiftly proceed southward, go around Cape San Lucas at the southern tip of the peninsula of Lower California, and fish for yellowfin and skipjack in the Gulf of California. In either case, tuna are the principal object of the fishery and there are almost no purse seiners which fish exclusively for skipjack.

The fishing grounds for these boats are centered around Cape San Lucas and are divided into those within the Gulf and those on the Pacific coast of Lower California. As soon as one rounds the Cape and enters the Gulf, the climate changes suddenly. Within the Gulf, the wind is generally light and the sea is very calm. The schools are mostly mixed tuna and skipjack and large schools of "sleepers" can be seen. It is a good ground for tuna purse seiners and many boats operate there before the black tuna season begins, that is during May, and during the light of the moon in the regular season.

Is there not some possibility of setting up a purse seine fishery for the schools in Japanese waters like that which is so splendidly established in America? Of course it is a question whether the form of the American fishery can be exactly imitated in our waters. It is hoped that the fishery will appear in a form suited to Japanese conditions and to Japanese fish. Then the solution to the problems of the fishery will be found in the use of the purse seine. This is the problem for the future.

Section 3 Conclusion

Since the end of the war, the skipjack fishery has been under discussion from all points of view, but in every case, a tendency can be seen to become preoccupied with mere externals without getting a full grasp of the essentials. Consequently, on the following page, we have cited some prewar statistics to serve as data for reference.

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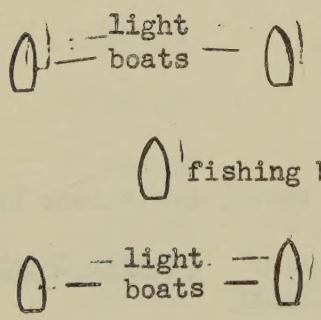

Figure 15 Positions of light boats

Note: Description of figures which have not been reproduced with the translation because of the difficulty of copying them onto hectograph carbon stencils.

Figure 1. A drawing of a skipjack (Katsuwonus pelamis)
Figure 9. A photograph of three horn lures
Figure 11. A photograph of three shell-inlaid feather lures
Figure 12. A photograph of three small two-hook trolling lures
Figure 13. Plans of a typical large steel skipjack boat

Table 6 Tendencies of Skipjack Boats

Year	Total Vessels	Boats Under 20 Tons	Boats Under 60 Tons	Boats Over 60 Tons
1924	2,511	2,237	243	3
1926	2,390	2,087	242	6
1930	1,857	366	346	45
1934	1,469	0	216	278
1938	1,009	319	348	342

(Note) The total number of boats has diminished, but the number of those over 50 tons has multiplied 114 times, and the catch per boat has increased markedly.

Table 7 Catches by Skipjack Boats Operating in Distant Waters

Year	Total Number of Fish	Year	Total Number of Fish
1920	13,981,867	1932	14,250,971
1923	12,735,940	1935	16,524,676
1926	14,408,046	1937	25,700,944
1929	16,040,225		

Table 8 Vessel Operations by Months for 1938

Month	Number of boats	Number of Fish Taken	Largest Catch	Number of boats Taking Over 10,000 Fish	Catch Per Boat [fish]
April	304	461,852	8,750	[?]	1,519
May	537	1,385,663	30,700	15	2,580
June	590	1,918,734	25,500	42	3,252
July	639	3,182,814	23,207	81	4,982
August	491	1,809,359	22,050	23	3,888
September	369	1,335,108	18,666	11	6,616

Table 9 Catch by Areas

(According to statistical reports
of the
Ministry of Agriculture and Forestry for 1937)

Prefecture	Number of Boats	Total Tonnage	Number of Fish Taken	Catch Per Boat
Shizuoka	129	10,474.33	7,122,626	55,214
Kagoshima	217	8,583.35	2,453,140	11,348
Mie	92	6,382.74	3,590,386	39,015
Miyagi	93	6,331.87	4,527,868	48,686
Kōchi	152	6,084.70	1,193,864	7,581
Tokushima	51	2,103.20	43,907	861
Kanagawa	25	2,065.00	177,867	7,114
Wakayama	73	2,005.76	794,147	10,879
Oita	57	1,892.03	3,500	61
Ibaraki	28	1,884.07	43,262	1,545
Miyazaki	60	1,575.00	482,100	8,035
Iwate	36	1,497.30	305,636	8,489
Chiba	24	954.99	262,449	10,935
Fukushima	9	734.74	182,550	20,283
Tōkyō	7	135.00	156,155	22,308
Ehime	17	464.93	290,300	17,079